
Draft

Supplemental Remedial Investigation Report Quanta Resources Superfund Site, Operable Unit 1

Prepared for
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Executive Summary

Background

This draft Supplemental Remedial Investigation (SRI) Report for Operable Unit (OU) 1 of the Quanta Resources Superfund Site¹ (the “Site”) presents the data and information gained from the work prescribed by the U.S. Environmental Protection Agency (EPA)–approved SRI Work Plan (CH2M HILL, 2008b); it serves to complete the RI process for OU1 by updating and complementing components of the final RI Report and addressing remaining comments from EPA and New Jersey Department of Environmental Protection (the “Agencies”). This executive summary updates that which was presented in the RI Report and highlights the major findings from the RI and SRI investigations.

A draft RI Report (CH2M HILL, 2007a) was submitted to the Agencies on November 17, 2007. Comments were received from the Agencies via Federal Express on April 7, 2008 (EPA, 2008a), and a final RI report addressing comments was submitted on August 29, 2008 (CH2M HILL, 2008a). During that period, and at the request of the Agencies, an SRI Work Plan (CH2M HILL, 2008b) was prepared. Following its approval by the Agencies, SRI activities were initiated, in July 2008. The SRI was designed to address specific data gaps and provide additional information needed for the development of a set of remedial alternatives for the Site.

The RI and SRI Reports were prepared according to requirements of the EPA Administrative Order on Consent II–Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)–2003-2012 for the Uplands Area, OU1 (EPA, 2003).

The Site is located in Edgewater, New Jersey, and is adjacent to the Hudson River (Figure ES-1). It consists of the former Quanta Resources property and any locations to which contamination from the property and former operations have migrated. Surface water and sediment in the Hudson River adjacent to OU1 constitute OU2 and are being investigated and addressed separately, pursuant to an EPA Administrative Order on Consent. Constituents associated with former Site operations have been observed in parts of the following areas, which together make up OU1 (Figure ES-2):

- Block 95, Lot 1 (the Quanta property)
- Block 91, Lot 1 (the former Celotex property²)
- Block 96, Lot 3.01 (the 115 River Road property)
- Block 99, Lot 1 (the former Lever Brothers property)

¹ As defined in the Administrative Order on Consent (AOC) II–CERCLA-2003-2012, the Quanta Resources Superfund Site includes the former Quanta Resources property, located on River Road in Edgewater, New Jersey, and any areas where contamination from the property has come to be located. The current Quanta property refers to Block 95, Lot 1, as defined on the Borough of Edgewater, New Jersey, tax map.

² This property may also be referred to as the Edgewater Enterprises property. Edgewater Enterprises, LLC, was a former owner of Block 91, Lot 1. The chain of title is provided in Appendix A of the RI Report.

- River and Gorge Roads
- Block 93 (north, central, and south)
- Block 94, Lot 1
- Block 92.01 (north of Gorge Road)

A substantial amount of data and information was collected and assessed during the OU1 RI and SRI, as prescribed in the EPA-approved “OU1 Remedial Investigation/ Feasibility Study (RI/FS) Work Plan” (Parsons, 2005) and associated Field Sampling Plan, Health and Safety Plan, and Quality Assurance Project Plan (QAPP); three RI/FS Work Plan addendums; additional EPA requests; and the “Final RI/FS Work Plan Addendum No. 4 for a Supplemental Remedial Investigation (SRI)” (CH2M HILL, 2008b).

The OU1 RI process has achieved the objective of completing a comprehensive site characterization, which included the following:

- Characterization of OU1 sources
- Determination of the nature and extent of contamination
- Evaluation of fate and transport of constituents of interest (COI)
- Assessment of potential risks to human health and the environment

The RI and SRI reports compiled data from and presented evaluations of the following:

- Field observations and analytical data from 105 soil borings
- Data from 126 TarGOST® borings
- Data from 72 groundwater-monitoring locations as well as piezometers installed in OU2
- Synoptic water level and NAPL thickness measurements (November 2008 and March 2009, in addition to four quarterly events in 2006) and synoptic water level measurements in the shoreline area during six tidal cycles
- In situ hydraulic conductivity data from tests at 14 wells and across all hydrostratigraphic units
- Collection and analysis of five water samples in areas where seasonal standing water had been observed
- Extensive non-aqueous phase liquid (NAPL) “fingerprinting” data
- NAPL physical characteristics data
- Soil vapor and indoor and outdoor air analyses and building surveys
- In situ subsurface and surface conductivity and temperature data from 55 OU2 locations
- Analytical data for pore water and surface water from five OU2 locations
- Data from the bulkhead geophysical survey
- Comprehensive site survey and surveys of new wells and borings
- Subsurface utility surveys

Evaluations of data from over 30 previous reports and memoranda prepared for properties within or adjacent to OU1 were reviewed and incorporated into the Site characterization. The Site is well understood for purposes of supporting remedial alternative development, evaluation, and selection. The conceptual site model developed during the RI process is presented in Figure ES-3.

The most significant conclusions from the RI and SRI are as follows:

- All primary sources have been removed, with the exception of some buried piping on the Quanta property.
- Site-related secondary sources of polycyclic aromatic hydrocarbons (PAHs), aromatic volatile organic compounds (VOCs), and other constituents – including NAPL, pitch, and impacted soil – have been identified, characterized, and fully delineated.
- The foremost Site-related secondary source of arsenic, iron, sulfate, and – to a lesser extent – other metals within OU1 is the remnants of oxidizing pyrite ore (reddish-purple soils) within the footprint of a former acid plant in the northwest portion of the Quanta property and in the former Celotex property. This area of source material, referred to as the High-Concentration Arsenic Area (HCAA), has been comprehensively characterized.
- Three separate sources of arsenic outside the HCAA have been delineated and characterized within the footprint of OU1: a small area in the northern portion of the former Lever Brothers property that, like the HCAA, exhibits an acid waste leachate signature, and two other distinct areas within OU1 where elevated arsenic concentrations in groundwater are the result of a combination of the groundwater geochemical environment and the presence of arsenic hotspots within the ubiquitous heterogeneous fill material known to contain, wood, coal, coal ash, and glassy slag. The fill material throughout the area contains metals and PAHs largely unrelated to former operations at OU1. The groundwater geochemical environment in these areas is influenced by sources of dissolved phase organics including, NAPL, native peat and organic silts, as well as the organic-rich fill.
- Primary constituents exceeding EPA and state screening criteria include arsenic in soil and groundwater, dissolved phase constituents in groundwater associated with NAPL (e.g., naphthalene), and PAHs in soils; the extent of these constituents has been defined in all directions downgradient of areas of historical operations and where secondary sources in soil remain.
- NAPL is present in discrete zones above and within the top few feet of a silty clay confining layer. Six NAPL zones representing most NAPL (NZ-1 through NZ-6) have been identified and delineated at the Site (Figure ES-4). Small pockets of NAPL existing outside the defined NAPL zones are not connected with one another or the larger contiguous NAPL zones. The potential for NAPL migration varies among the six discrete NAPL zones on the basis of the varying physical characteristics of the NAPL and the subsurface. Free-phase NAPL is recoverable in some areas but appears to be substantially immobile and unable to affect sensitive receptors, with the exception of NAPL in the zones adjacent to the Hudson River, which may be affecting surface water and sediments in nearshore areas. NAPL distribution near the bulkhead suggests that it has accumulated behind the bulkhead and has flanked it to the north and south beyond

its extents. NAPL unrelated to the Site is also present to the south, near monitoring wells MW-106A and MW-7.

- The silty clay confining unit for groundwater with limited thickness is present at the Site. This unit hydraulically separates the shallow, unconfined groundwater (in native soils and fill) from the lower, deeper, confined sand unit.
- The wooden bulkhead impedes groundwater flow from OU1 to OU2, and groundwater flowing eastward towards the bulkhead moves to the north and south once it reaches the shoreline. Visual and hydraulic data indicate that the structure is not a complete barrier to groundwater or NAPL movement from OU1 to OU2.
- Concentrations of representative constituents in groundwater have generally been steady and decline with distance from sources. Additionally, the concentrations over time for representative parameters appear to be generally stable or decreasing.
- Arsenic solubility in groundwater is largely a function of three mechanisms: (1) leaching of acid wastes in two areas, (2) reductive dissolution of iron and arsenic, and (3) competition for adsorption sites from the presence of orthophosphate. As with other constituents in groundwater, arsenic concentrations are generally constant over time and decline with distance from source areas. Arsenic associated with HCAA attenuates in groundwater through mineral precipitation and adsorption processes and does not migrate to the surface water of the Hudson River.
- Organic constituent and arsenic concentrations in shallow pore water in the nearshore area are present at low or nondetectable levels. Concentrations of these constituents in pore water in the nearshore area include contributions from NAPL and adsorbed NAPL constituents or arsenic in the sediment at OU2. Soluble arsenic associated with shoreline fill at OU1 may be contributing to observed arsenic concentrations in shallow pore water north of the bulkhead, albeit at a significantly reduced concentration below surface water screening criteria.
- The area affected by the potential flux of NAPL constituents from groundwater to surface water is limited to nearshore areas adjacent to and at the ends of the wooden bulkhead. Arsenic was not detected in the surface water at OU2.
- Remediation triggers developed as part of the Baseline Risk Assessment were exceeded in soil and shallow groundwater for at least one assumed future receptor at the five properties evaluated. Surficial tar “boils” identified during the RI will also be addressed during future remedial actions.

Following is a brief summary of the major findings from the RI and SRI field investigations and conclusions based on the assessment of data and information collected.

Sources

Sources of Site-related constituents have been identified and characterized. Coal tar-processing and subsequent oil-recycling operations contributed to existing secondary sources of contamination at the Site, including NAPL, pitch, and soil impacted with PAHs. A former acid plant that straddled the northern portion of the Quanta property and

southern portion of the former Celotex property contributed to the presence of oxidizing pyrite ore remnants in soil. Primary sources are no longer present, with the possible exception of buried piping on the Quanta property.

Additional secondary sources contributing to soil and groundwater contamination unrelated to former operations (such as regional fill material and former operations on adjacent properties) are present within the extent of OU1. Secondary sources of constituents in groundwater and/or soil unrelated to but within the extent of OU1 include the following:

- Fill material, unrelated to former Site operations, throughout this part of Edgewater
- Identified Areas of Concern related to the former Lever Brothers property – including constituents in soil and groundwater associated with light non-aqueous phase liquid (LNAPL), petroleum-related constituents in soil, pitch/asphaltic material in the northern and central portions of this property, and a secondary arsenic source area exhibiting an acid leachate signature)
- An upgradient source of chlorinated solvents impacting shallow upgradient groundwater and groundwater within the confined deep sand unit
- Polychlorinated biphenyls (PCBs) in soil near the former oil recycling operations and at adjacent properties

NAPL

The location, nature, and extent of the NAPL at OU1 have been defined. Free-phase and residual NAPL are present at the Site, and samples from monitoring wells have been identified as consisting at least partially of coal tar. Most free-phase NAPL is denser than water and present in discrete areas (or zones) above and within the top few feet of the silty clay confining layer. Free-phase NAPL is recoverable but in most areas not characteristically mobile; despite the age of the release(s), it remains proximal to former primary sources (historical tank farms). An exception to this is the deeper NAPL at NZ-3, which is characteristically mobile but appears to be substantially contained by depressions in the surface of the silty clay confining unit to the south of the Quanta property. Adjacent to the shoreline, the physical characteristics of the NAPL, its distribution, the architecture of controlling lithologic interfaces, and observations in the adjacent nearshore sediments suggest that it should be considered mobile. Shoreline NAPL south of the bulkhead at the former Lever Brothers property is present in thin lenses that consist of residual NAPL.

Since most NAPL at OU1 is denser than water, the NAPL has migrated downward by gravity but has been halted by either increasing pore pressure with depth or by the surface of the silty clay confining layer. The lateral and vertical extents of NAPL at OU1 are generally stable under current conditions. Migration is constrained by either the physical properties of the NAPL (i.e., high viscosity and interfacial tension), the soil pore size, or the presence of physical barriers such as the silty clay confining unit or the native peat unit. NAPL identified at depth has been found to accumulate in the natural depressions in the surface of the confining unit owing to gravity and the upward sloping surfaces of the silty clay confining unit to the south. However, historic geotechnical borings completed in the northern portion of the former Lever Brothers property indicate that the silty-clay unit dips

south and east beyond where the deeper NAPL is present as thin and discontinuous lenses. If additional migration were to occur, it would follow the silty-clay surface to depths of at least 75 feet below ground surface (bgs), where it would have no potential to migrate to surface water or sediments associated with the Hudson River. The effects on NAPL mobility of future development activities such as excavation or placement of fill material, placement of subsurface structures, or pumping of groundwater should be considered when specific development plans have been defined.

Solid tar has been observed in several soil borings at the Site in the form of a black, soft to stiff, semiplastic to plastic material at discrete depth intervals with a thicknesses ranging from 0.3 foot to approximately 6 feet. Three main areas where the solid tar was observed in borings or excavations have been identified: (1) the eastern portion of Block 93 North, (2) the western portion of the Quanta property, and (3) adjacent to the Hudson River on the Quanta property. Surficial tar boils have also been observed within or near the solid tar areas.

Constituents Exceeding Screening Criteria

The primary constituents exceeding the lowest applicable EPA and state screening criteria are arsenic in soil and groundwater and PAHs and aromatic VOCs associated with NAPL in soil and groundwater (e.g., benzo(a)pyrene, naphthalene, and benzene).

Organic Constituents

Organic constituents in groundwater include SVOCs and VOCs. Some limited detections of chlorinated solvents have also been observed in the shallow upgradient groundwater at the foot of the Palisades and in deeper confined groundwater; they are likely from an upgradient release. No significant detections of chlorinated solvents have been observed in OU1 soils or in NAPL.

Concentrations of organic constituents in groundwater have remained generally constant or have decreased over time and decline with distance from sources. The footprint of the composite extent of these constituents in groundwater is not expanding as organic constituents are in equilibrium because of adsorption and degradation processes. Shallow unconfined groundwater flow is generally towards the east (Hudson River) and south (former Lever Brothers property) at an average flow velocity of approximately 0.55 foot/day. As groundwater moves from source areas at OU1 adjacent to the Hudson River, it encounters additional sources of NAPL and adsorbed constituents in the nearshore sediments of OU2. Despite the presence of these additional sources, dissolved-phase organic constituents are subjected to further attenuation as they move upward to the surface water of the Hudson River. Organic constituents were detected in shallow pore water in groundwater-upwelling zones in the nearshore area of OU2; surface waters collected in this area contained low or nondetectable levels of NAPL constituents.

Inorganic Constituents

Inorganic constituents in groundwater include arsenic, iron, sulfate, ammonia, and to a lesser extent lead and other metals. The main source of lead is the storage and/or combustion of pyritic ore. Another source of lead in soil and groundwater is the ubiquitous heterogeneous, slag-rich fill material. Elevated levels of lead in soil are present throughout

the former Celotex property and are not as abundant elsewhere at the Site. Due to the relative immobility of lead, elevated concentrations do not persist in groundwater downgradient of pyritic source areas associated primarily with the former acid plant in the northwest portion of the Site. Rather, lead is quickly adsorbed to organics or hydroxide minerals or precipitated.

Soil data, visual observations, documented mineralogical differences, and geochemical signatures suggest that two types of arsenic sources exist within OU1 soils. The first exhibits a geochemical signature consistent with acid waste leaching and includes the remnants of oxidizing pyrite ore (reddish-purple soils) within the footprint of a former acid plant and, to a lesser extent, a separate localized area of soils in the northern portion of the former Lever Brothers property. The second source type is associated with the slag-containing fill material throughout OU1 and the surrounding area.

Localized hot spots of arsenic within the heterogeneous fill where geochemical conditions promote the reductive dissolution of arsenic and iron act as sources of arsenic to groundwater. Elevated arsenic concentrations in soil associated with the former acid plant have been defined and do not extend beyond the southwestern portion of the Celotex property or northwestern corner of the Quanta property. This material is generally associated with the reddish-purple soils within the footprint of the former acid plant.

Both the oxidation of pyrite and reductive dissolution within the fill material are sources of arsenic in groundwater across OU1 and at adjacent properties. Concentrations of dissolved arsenic within and downgradient of each of these source types are controlled largely by the precipitation of iron oxyhydroxides and competition with orthophosphates for sorption sites associated with the iron. Arsenic concentrations in groundwater are generally constant over time and decline with distance from the primary and secondary source areas.

Arsenic associated with the former acid plant and the secondary pyritic source attenuates in groundwater through mineral precipitation and adsorption processes and does not migrate to the Hudson River. Additional secondary sources of arsenic related to fill material have contributed to arsenic concentrations adjacent to the Hudson River. Dissolved arsenic in pore water along the shoreline is due largely to equilibrium of the interstitial water with sediment-associated arsenic. The one exception to this is north of the bulkhead, where NAPL is present and reductive dissolution of arsenic associated with the nearshore fill may be contributing to the presence of dissolved arsenic in the pore water at an adjacent groundwater-upwelling zone. Concentrations of arsenic in the surface water of OU2 were below detection limits, suggesting that a measurable flux of arsenic from nearshore fill and the sediments to the surface water of the Hudson River is not occurring.

Risk Assessment

[Forthcoming.]

Conclusions and Next Steps

The Site has been characterized and is well understood for purposes of supporting OU1 remedial alternative development, evaluation, and selection. The extent of OU1

contamination for groundwater, soil, and NAPL based on the data and evaluations presented in the RI and SRI is shown in Figure ES-5.

Additional work performed as part of the SRI has been successful in addressing the remaining comments on the draft RI report through the closure of identified data gaps and achievement of all the objectives set forth in the SRI Work Plan (CH2M HILL, 2008b) and approved by the Agencies. This SRI Report serves to update the applicable components of the final RI (CH2M HILL, 2008a) and complete the RI process for the Site. A copy of the final RI report has been included as an appendix to the SRI report to provide one comprehensive report that documents the entire RI process.

The next step is to complete the development and evaluation of OU1 remedial alternatives, which will be documented in the draft OU1 Feasibility Study (FS) Report. The FS for OU1 will evaluate technologies and develop and screen remedial alternatives on the basis of RI and SRI findings to

- Reduce current and/or potential future human health risks to acceptable levels at the properties comprising OU1, including limiting potential future contact with NAPL
- Prevent erosion, transport, or migration of constituents of concern (COCs) in soil or groundwater offsite or to OU2 at concentrations resulting in human or ecological risk above acceptable levels

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- L Form As and Form Bs
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- N Groundwater, Pore Water, and Surface Water Analytical Data for Non-PAH SVOCs
- O Groundwater, Pore Water, and Surface Water Analytical Data for Volatile Organic Compounds (VOCs)
- P Groundwater, Pore Water, and Surface Water Analytical Data for Total/Dissolved Inorganics
- Q Groundwater Analytical Data for Polychlorinated Biphenyls (PCBs)
- R Groundwater and Pore Water Analytical Data for Water Chemistry
- S Sample to Sample Delivery Group (SDG) Cross Reference and Laboratory Reports (disk enclosed)
- T NAPL Analytical Data for Expanded Semi-Volatile Organic Compounds (SVOCs) and Fingerprinting
- U NAPL Analytical Data for Biomarkers
- V Coastal Monitoring Associates Report
- W Quanta Hager-Richter Geophysics Reports
- X QA/QC Evaluation
- Y Historic Geotechnical Boring Logs – Former Lever Brothers Property
- Z Photo Log
- AA Soil Petroleum Fingerprinting Data
- BB Concentration vs. Time Plots – Arsenic, Benzene, and Naphthalene
- CC Mann-Kendall Trend Analysis
- DD Sequential Extraction Procedure Results – Pie Charts
- EE USEPA Ground Water and Soil Analysis
- FF Concentration vs. Distance Plots – Arsenic Transects

Acronyms and Abbreviations

ASA	arsenic source area
AST	aboveground storage tank
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
BL	Boart Longyear
bss	below sediment surface
BTAG	Biological Technical Assistance Group
BTEX	benzene, toluene, ethyl benzene, and xylene
CDM	Camp Dresser & McKee, Inc.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
CMA	Coastal Monitoring Associates
COC	constituent of concern
COI	constituent of interest
COPC	constituent of potential concern
CSM	conceptual site model
cSt	centistoke
DI	deionized
DMA	dimethylarsenic acid
DNAPL	dense non-aqueous phase liquid
DPT	direct-push technology
EM31	frequency domain electromagnetic induction
EM61	time domain electromagnetic induction two-dimensional resistivity profiling
EPA	U.S. Environmental Protection Agency
EPI	Environmental Probing Investigations, Inc.
fl/py	fluorene-to-pyrene ratio
FS	feasibility study
GPR	ground-penetrating radar
GW/SW	groundwater-surface water
HCAA	high-concentration arsenic area
HHRA	human health risk assessments
IDW	investigation-derived waste
LNAPL	light non-aqueous phase liquid
MCL	Maximum Contaminant Level
MMA	monomethylarsonic acid
MGP	manufactured-gas plant

mS	millisiemen
msl	above mean sea level
mV	millivolt
NAD 1983	New Jersey State Plane Coordinate System
NAPL	non-aqueous phase liquid
NAVD 1988	North American Vertical Datum
NJGWQS	New Jersey Groundwater Quality Standard
NPL	National Priorities List
NZ	NAPL zone
ORP	oxidation reduction potential
OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PID	photoionization detector
ppmv	parts per million by volume
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
QAPP	quality assurance project plan
RE	reference emitter
RI	remedial investigation
RI/FS	Remedial Investigation/Feasibility Study
RSI	Removal Site Investigation
RSL	Regional Screening Level
SEP	sequential extraction process
SGS	SGS Environmental Services, Inc.
SLERA	Screening Ecological Risk Assessment
SRI	Supplemental Remedial Investigation
SVOC	semivolatile organic compounds
TAL	Target Analyte List
TDS	total dissolved solids
TMB	trimethylbenzene
TPH	total petroleum hydrocarbon(s)
UST	underground storage tank
VOC	volatile organic compound

SECTION 1

Introduction

This draft Supplemental Remedial Investigation (SRI) Report for Operable Unit (OU) 1 of the Quanta Resources Superfund Site¹ (the “Site”), located in Edgewater, New Jersey (Figure 1-1), has been prepared according to the requirements of the U.S. Environmental Protection Agency (EPA) Administrative Order on Consent II–Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)–2003–2012 for the Uplands Area, OU1 (EPA, 2003). The Site is located adjacent to the Hudson River, in northeastern New Jersey. Surface water and sediment in the Hudson River are considered OU2 and are being investigated pursuant to a separate EPA Administrative Order on Consent. The Site was listed on the National Priorities List (NPL) on September 9, 2002. Consistent with the OU1 Administrative Order, the site characterization, remedial evaluation, and selection process are being conducted pursuant to the EPA National Oil and Hazardous Substances Pollution Contingency Plan (40 Code of Federal Regulations [CFR] 300), “Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA” (EPA, 1988), and other relevant guidance as stated in this report.

A draft RI Report (CH2M HILL, 2007a) was initially submitted to the EPA and New Jersey Department of Environmental Protection (hereafter referred to as the Agencies) on November 17, 2007. Comments were received from the Agencies via Federal Express on April 7, 2008 (EPA, 2008a). The Agencies’ comments were addressed in the final RI Report, which was submitted on August 29, 2008 (CH2M HILL, 2008a). On the basis of these comments and subsequent meetings and discussions, EPA determined an SRI would be required to address data gaps and provide additional information needed for developing a set of remedial alternatives for the Site.

Prior to submission of the final RI Report, the “Final Remedial Investigation/Feasibility Study (RI/FS) Work Plan Addendum No. 4 for a Supplemental Remedial Investigation” (SRI Work Plan) (CH2M HILL, 2008b) was drafted and originally submitted on May 19, 2008, to address the remaining Agency comments on the draft RI Report that required additional data collection activities. Approval of the final SRI Work Plan, dated July 31, 2008 was received from the EPA in an e-mail message dated October 7, 2008.

SRI field activities were conducted from July 2008 through March 2009. EPA oversight was provided by Camp Dresser & McKee, Inc. (CDM). CDM documented the field activities and collected split samples of the various media collected during all phases of the RI activities. In addition, select split-samples of soil were shipped from the laboratory to EPA’s National Risk Management Research Laboratory in Ada, Oklahoma. The results of analyses performed on soil samples sent to Ada and those performed on select groundwater samples collected by CDM were provided by the EPA in a technical memorandum dated March 11, 2009a.

¹ As defined in the Administrative Order on Consent (AOC) II–CERCLA–2003–2012, the Quanta Resources Superfund Site includes the former Quanta Resources property, located on River Road in Edgewater, New Jersey, and any areas where contamination from the property has come to be located. The current Quanta property refers to Block 95, Lot 1, as defined on the Borough of Edgewater, New Jersey, tax map.

This SRI Report presents the data and information related to the work prescribed by the EPA-approved SRI Work Plan (CH2M HILL, 2008b); it serves to complete the RI process for the Site (OU1) by updating the applicable components of the final RI Report and addressing the Agencies' remaining comments.

To provide a comprehensive, stand-alone document that addresses all the necessary components of the RI according to CERCLA guidance (EPA, 1988), a complete copy of the final RI Report and its appendices has been included as Appendix A to this SRI Report. Figures that were originally provided in the RI Report that have been updated as part of the SRI and included herein are noted as such. The significant updates to the findings presented in final RI Report are summarized in Section 1.5.

1.1 SRI Work Plan (RI/FS Work Plan Addendum No. 4)

Following the completion of field work associated with the RI in 2006, additional data gaps were identified and presented to the Agencies during a meeting on December 19, 2006. The specific data gaps identified included the determination of the distribution and extent of NAPL and Site-related constituents at Block 93 and in the northwest portions of the former Lever Brothers property; the extent of Site-related, dissolved-phase constituents in groundwater at Block 93; the extent of arsenic in groundwater surrounding the MW-111 cluster of wells; and the groundwater flow direction in the north portion of Block 93. The "Proposed Scope of Work—Supplemental Data Gap Sampling" (RI/FS Work Plan Addendum No. 2) (CH2M HILL, 2007b), which was designed to address these data gaps, was submitted to the Agencies for review on March 22, 2007. Because the remaining data gaps were not expected to fundamentally change the outcome of remedial option evaluations for the Site, EPA requested that CH2M HILL proceed with its preparation of the draft RI Report (CH2M HILL, 2007a).

Subsequently, an "RI/FS Work Plan Addendum No. 3 and Field Sampling Plan for the Characterization of Cinder/Ash and Reddish-Purple Soils" (CH2M HILL, 2007c) was prepared at the request of EPA to address additional questions in connection with the presence of arsenic source material. The associated field work occurred in June 2007, and the activities performed as part of the characterization are included in the final RI Report (Appendix A).

Before receiving comments on RI/FS Work Plan Addendum No. 2 (CH2M HILL, 2007b), CH2M HILL modified and resubmitted it in May 2008 as a draft "Remedial Investigation/Feasibility Study Work Plan Addendum No. 4 for a Supplemental Remedial Investigation" (SRI Work Plan) (CH2M HILL, 2008c). These modifications were made to accommodate the specific comments from the Agencies on the draft RI Report (EPA, 2008a) that required additional field effort and data evaluations to address. Comments on the draft SRI Work Plan, received from the Agencies via e-mail messages sent on June 19, June 27, July 8, and August 27, 2008, were addressed and incorporated into the final SRI Work Plan (CH2M HILL, 2008a).

The final SRI Work Plan was designed to address data gaps at Blocks 93 North, Central, and South; Block 94 (west of Old River Road); within the intersection of Gorge and River Roads; and in the northwestern portion of the former Lever Brothers property. This SRI Report

presents the data that were collected and evaluated to address these data gaps. The specific objectives of the final, approved SRI Work Plan that are the focus of this SRI Report are summarized in Section 1.2.

1.2 Objectives

The overall and specific objectives identified in the final EPA-approved SRI Work Plan have been met. The overall objective of the SRI was to develop a dataset of sufficient quantity and quality to adequately assess the nature and extent of constituents at OU1 and to assess the potential risks posed by affected media to allow for the development of appropriate and effective mitigation/cleanup alternatives. To sufficiently address EPA comments on the RI Report (Appendix A) and to provide information to close data gaps identified in the RI Report, specific objectives were developed and are presented below in context of the Agencies' comments on the draft RI Report that the objectives are intended to address:

Objective	Draft RI Comment(s) Addressed	Section(s) of SRI Report that Address Objective
1 Determine the nature and extent of Site-related constituents and arsenic in the vicinity of Block 93 and the northwest portion of the former Lever Brother's property and in the intersection of Gorge and River Roads.	GC 5; SC 73, 97a	4.1, 4.2, 4.3, 5.1,5.2
2 Determine the nature and extent of NAPL in the northeastern portion of the former Lever Brother's property (near MW-106A)	SC 46	4.1.2
3 Refine nature and extent of NAPL behind and at the flanks of the wooden bulkhead	SC 83, 85,104; BTAG 6, 8	4.1.2
4 Determine the dimensions of the wooden bulkhead to evaluate its role in limiting NAPL migration	SC 83, 96a, 97a; BTAG 6, 8	3.2
5 Supplement existing data to sufficiently characterize risk to human health at Block 93 Central and South and for groundwater at the Site as a whole	GRAC 1	7
6 Begin collection of data to confirm stability of organic constituents and arsenic in groundwater at OU1	SC 39, 92c; ACC 7	2.1.8, 4.4.1, 5.3.5
7 Confirm distribution and mobility of arsenic in groundwater within and downgradient of suspected source zones at OU1	SC 92b, 92d, 96c, 116a; ACC 1, 2, 3, 6	5
8 Characterize groundwater flow paths and distribution and fate and transport of coal tar constituents (VOCs and PAHS) and arsenic across the groundwater–surface water (GW/SW) transition zone(s) between OU1 and OU2	GC 18; SC 83, 85, 96a, 97a, 104; BTAG 9, 10	3.1, 3.3, 4.3.4, 4.4.2, 5.2.2, 5.3.6

GC, general comment; SC, specific comment; ACC, arsenic/cinder comment; BTAG, Biological Technical Assistance Group comment; GRAC, general risk assessment comment.

The significant updates to the findings presented in final RI Report are summarized in Section 8. Figures that were originally provided in the RI Report that have been updated as part of the SRI and included herein are the following:

<i>RI Figure</i>		<i>Corresponding Updated SRI Figure</i>	
No.	Description	No.	Description
1-1	Study Area Location Map	1-1	Study Area Location Map
3-2	Geologic Cross-Sections A to A' and B to B'	3-1	Cross Section A-A**
		3-2	Cross Section B-B**
3-3	Geologic Cross-Sections C to C' and D to D'	3-3	Cross Section C-C**
		3-7	Cross Section G-G' (replaces D-D')*
3-4b	Elevation Contour Map—Top of Silty Clay	2-5	Silty-Clay Surface Contour Map
3-4c	Elevation Contour Map—Top of Bedrock	3-10	Bedrock Surface Contour Map
3-5	Water Table Elevation Contour Map, Oct. 16, 2006, Water Table, Mid-Tide	3-16	Potentiometric Surface Contour Map—March 2009—Shallow GW
3-6	Potentiometric Elevation Contour Map, Oct. 16, 2006, Deep Sand Unit Groundwater	3-15	Potentiometric Surface Contour Map—March 2009—Deep GW
4-3	Cross Sections Showing Coal Tar Distribution Based on TarGOST®	3-1–3-7	Cross sections A-A' to G-G' include updated depictions of NAPL and residual NAPL
4-4	Lateral Extent of NAPL and Coal Tar Impacts	3-8	Revised Lateral Extent of NAPL Based on SRI
4-9	Soil Isoconcentration Contours—Benzo(a)pyrene (0–4 feet bgs)	4-2	Soil Isoconcentration Contours—Benzo(a)pyrene (0–4 ft.)
4-10	Soil Isoconcentration Contours—Benzo(a)pyrene (> 4 feet bgs)	4-3	Soil Isoconcentration Contours—Benzo(a)pyrene (> 4 ft.)
4-11	Soil Isoconcentration Contours—Naphthalene (0–4 feet bgs)	4-6	Soil Isoconcentration Contours—Naphthalene (0–4 ft.)
4-12	Soil Isoconcentration Contours—Naphthalene (> 4 feet bgs)	4-7	Soil Isoconcentration Contours—Naphthalene (> 4 ft.)
4-17	Soil Isoconcentration Contours—Benzene (0–4 feet bgs)	4-4	Soil Isoconcentration Contours—Benzene (0–4 ft.)
4-18	Soil Isoconcentration Contours—Benzene (> 4 feet bgs)	4-5	Soil Isoconcentration Contours—Benzene (> 4 ft.)
4-21	Soil Isoconcentration Contours—Lead (0–4 feet bgs)	5-3	Soil Isoconcentration Contours—Lead (0–4 ft.)
4-22	Soil Isoconcentration Contours—Lead (> 4 feet bgs)	5-4	Soil Isoconcentration Contours—Lead (> 4 ft.)
4-23	Soil Isoconcentration Contours—Arsenic (0–4 feet bgs)	5-1	SRI-Soil Contours—Arsenic (0–4 ft.)
4-24	Soil Isoconcentration Contours—Arsenic (> 4 feet bgs)	5-2	SRI-Soil Contours—Arsenic (> 4 ft.)
4-27	Soil Isoconcentration Contours—PCBs (0–4 feet bgs)	4-8	Soil Isoconcentration Contours—PCBs (0–4 ft.)
4-28	Soil Isoconcentration Contours—PCBs (>4 feet bgs)	4-9	Soil Isoconcentration Contours—PCBs (> 4 ft.)
4-30	Groundwater Isoconcentration Contours—Benzo(a)pyrene (August 2006)	4-10	SRI-GW Contours—Benzo(a)pyrene

<i>RI Figure</i>		<i>Corresponding Updated SRI Figure</i>	
No.	Description	No.	Description
4-31	Groundwater Isoconcentration Contours—Naphthalene (August 2006)	4-12	SRI-GW Contours—Naphthalene
4-33	Groundwater Isoconcentration Contours—Dibenzofuran (August 2006)	4-13	SRI-GW Contours—Dibenzofuran
4-35	Groundwater Isoconcentration Contours—Benzene (August 2006)	4-11	SRI-GW Contours—Benzene
4-37	Groundwater Isoconcentration Contours—Lead (August 2006)	5-7	Groundwater Isoconcentration Contours—Dissolved Lead
4-38	Groundwater Isoconcentration Contours—Arsenic (2006/2007)	5-5	SRI-GW Contours—Dissolved Arsenic
4-41	Extent of Quanta Resources Superfund Site (OU1)	8-1	Extent of Quanta Resources Superfund Site—Operable Unit 1 (OU1)
5-1	Geochemical Parameter Contours—Eh, Shallow Groundwater	5-10	SRI-GW Contours—Shallow Eh
5-2	Geochemical Parameter Contours—Eh, Deep Unconfined Groundwater	5-11	SRI-GW Contours—Deep Unconfined Eh
5-3	Geochemical Parameter Contours—pH, Shallow Groundwater	5-12	SRI-GW Contours—Shallow pH
5-4	Geochemical Parameter Contours—pH, Deep Unconfined Groundwater	5-13	SRI-GW Contours—Deep Unconfined pH
5-5	Cross Sections Showing Coal Tar Distribution at OU1 and OU2 Based on TarGOST®	3-1–3-7	Cross sections A-A' to G-G' include updated depictions of NAPL and residual NAPL*
5-8	Geochemical Zones	5-15	Geochemical Zones
6-1	Conceptual Site Model for OU1	6-1	Updated Conceptual Site Model for OU1

* The cross-sections presented in the SRI were updated based on additional borings and may fall along different transects than the cross-sections presented in the RI.

1.3 Report Organization

The SRI Report describes the investigation activities completed as part of the SRI for OU1 and summarizes the resulting data. The main body of the SRI Report presents evaluations of both historical and recently collected data as they relate to addressing the specific objectives discussed above. A brief summary of each of the sections comprising the SRI Report is as follows:

- Section 1 briefly describes the Site, summarizes the objectives of the SRI, outlines the structure of the report and highlights the areas where significant changes to the RI Report have been made.
- Section 2 details the field activities conducted according to the SRI Work Plan, described in Section 1.1.

- Section 3 presents updates on the Site characteristics including refinements to the Site-specific geology and hydrogeology and new information on the wooden bulkhead structure.
- Section 4 presents the findings for the field investigation as they pertain to NAPL and coal tar constituents and the nature and extent and fate and transport of NAPL and NAPL-related constituents in Site media.
- Section 5 presents the findings for the field investigation as they pertain to arsenic and the nature and extent and fate and transport of arsenic in groundwater within and downgradient of source areas in Site media.
- Section 6 presents an updated conceptual site model for OU1.
- Section 7 summarizes the conclusions of the human health risk assessments (HHRAs) performed for newly investigated properties and for groundwater at the Site as a whole. It also provides an evaluation of SRI data collected at properties where HHRAs were previously performed as part of the RI.
- Section 8 presents the conclusions of the SRI Report relative to the specific SRI objectives.
- Section 9 lists the references used during the preparation of the SRI Report.

Figures and tables, listed in the table of contents, are referenced throughout the text and are found at the end of the report text. Twenty-seven appendixes present the detailed supporting information, data, and field observations used to develop the evaluations presented in this report.

Through its inclusion of the final RI Report as Appendix A, this report serves as a complete summary of all data and evaluations used to complete the RI process for the Site.

1.4 Definitions

Definitions that will be used throughout this document include the following:

- **Quanta property:** The land portion of Block 95, Lot 1, in Edgewater, New Jersey.
- **Former Quanta Resources property:** The land portion of Block 95, Lot 1, and Block 93, Lot 1, as well as the portion of River Road between these lots.
- **Quanta Resources Superfund Site:** As defined in the AOC II-CERCLA-2003-2012, the Quanta Resources Superfund Site includes “the former Quanta Resources Site and any areas where contamination from the Site has come to be located.” The extent of OU1 has been updated as part of this report.
- **Former Barrett property:** The maximum extent of Barrett Manufacturing Company operations as depicted on historical Sanborn® fire insurance maps for 1900, 1911, 1930, 1944, 1950, and 1968 (included in Appendix A of the final RI Report; the entire final RI Report is included as Appendix A to this SRI Report).

- **Former Celotex property:** The land portion of Block 91, Lot 1 (north of the Quanta property).
- **Former acid plant:** A chemical plant that produced acids, alums, sodium compounds, and sulfuric acid (Parsons, 2005) at the former Celotex property and the northwest portion of the current Quanta property between from at least 1900 until 1957.
- **115 River Road property:** The land portion of Block 96, Lot 3.01 (south of the Quanta property).
- **Former Lever Brothers property:** The land portion of Block 99, Lots 1, 3, and 4 (south of the 115 River Road property).
- **Block 93:** Three separate properties located to the west of River Road; Block 93 North which consists of Block 93, Lot 1, the northern portion of Lot 2, and Lot 3; Block 93 Central, which consists of Block 93 Lots 1.01, 3.03, 3.04, and the southern portion of Lot 2; and Block 93 South, which consists of Block 93, Lot 1.02 and Lot 4.
- **Block 94:** Block 94, Lot 1, located to the west of Block 93 and Old River Road.
- **NAPL:** Non-aqueous phase liquid, or “product.” NAPL can exist as a single chemical component or as a mixture, and it can occur in soils in free-phase or residual states. Residual NAPL is defined as being immobile when soil capillary forces are greater than gravity and hydraulic forces (Cohen and Mercer, 1993). Free-phase NAPL moves under the force of gravity and hydraulic forces. In this report, the term “NAPL” refers to both free-phase and residual states, unless otherwise noted.
- **LNAPL:** Light non-aqueous phase liquid. LNAPL has a density less than 1.0.
- **DNAPL:** Dense non-aqueous phase liquid. DNAPL has a density greater than 1.0.
- **Coal tar,** characterized by a complex and variable mixture of compounds, typically complex high-molecular-weight hydrocarbons and other byproducts from former manufactured-gas plant (MGP) operations (Hayes et al., 1996; EPA, 2000). At the site, coal tar was delivered to the former Barrett property for use by the Barrett Company Shadyside² Plant for production of roofing paper and other materials.
- **COC:** Constituent of concern. Constituent present at concentrations exceeding calculated acceptable risk ranges in the Ecological and Human Health Risk Assessments.
- **COI:** Constituent of interest. Constituent present at concentrations exceeding one or more screening criteria.

² The town of Edgewater was formerly known as Shadyside, New Jersey.

SECTION 2

Investigation Summary

The following subsections outline the tasks completed and procedures followed for the work that was performed according to the SRI Work Plan (CH2M HILL, 2008b).

The EPA-approved SRI Work Plan identified specific data objectives, as outlined in Section 1.1. Activities performed to achieve those objectives included the following:

- Completion of 31 soil borings through direct-push methods
- Completion of 21 soil borings (18 of which were converted to monitoring wells, piezometers, or cased boreholes) through rotosonic drilling methods
- Completion of two soil borings (both of which were converted to monitoring wells) through hollow stem auger drilling methods
- Completion of 28 TarGOST® borings
- Collection of 97 soil samples for laboratory analysis
- Installation and development of 15 groundwater-monitoring wells
- Installation and development of three clusters of nine piezometers along the Quanta property shoreline
- Installation of 15 piezometers within OU2
- Installation of two cased boreholes for use in bulkhead geophysical survey
- Collection of 46 groundwater samples for laboratory analysis from new and existing monitoring wells
- Measurements of synoptic water level and NAPL thickness (November 2008 and March 2009)
- Measurements of synoptic water levels in the shoreline area during six tidal cycles
- Collection of three NAPL samples for laboratory analysis
- Completion of Trident probe surveys at 55 locations and a Trident probe pore water sampling event at which five surface water and five pore water samples were collected
- Completion of bulkhead geophysical survey
- Survey of all newly completed soil borings, monitoring wells, and piezometers.
- Completion of a topographical survey of the OU1 ground surface, a property boundary survey, and a site surface features survey

2.1 Investigation Procedures

The following subsections detail the procedures for advancing soil borings, collecting soil samples, installing monitoring wells, collecting groundwater samples, performing TarGOST® profiling, sampling pore water and surface water, surveying, and other activities conducted during implementation of the SRI Work Plan (CH2M HILL, 2008b), as described in Section 1.2.

2.1.1 Subsurface Utility Survey

The New Jersey One Call utility mark-out service was called prior to the start of the subsurface investigation activities. This service notified Time Warner Cable, Verizon, United Water New Jersey, PSE&G Gas Division, and Bergen County Department of Public Works. In addition, a private geophysical survey was performed by Enviroskan of Lancaster, Penn., in selected areas to augment the New Jersey One Call mark-outs. The purpose of the utility mark-outs was to assess whether subsurface obstructions were present where intrusive SRI field activities would take place. The survey was conducted near each of the proposed subsurface investigation locations (conventional soil borings and TarGOST® investigation locations) on the former Lever Brothers and former Celotex properties and on Blocks 93 North, Central, and South; Block 92.01; Block 94; River Road; and Gorge Road. A report, including a table of suspected utilities found near each location and a figure showing boring locations with suspected underground utilities, is in Appendix B.

2.1.2 Boring Advancement

Soil borings were completed during SRI activities to depths ranging from 15 to 75 feet below ground surface (bgs) to collect representative soil samples, characterize subsurface geological conditions, and evaluate the nature and extent of contamination. Soil boring advancement activities began on August 19, 2008, and were concluded on October 17, 2008, with additional soil boring advancement activities continuing on February 24 and 25, 2009, on Block 94 and Block 92.01. Sixty-five soil borings were advanced during the SRI activities, of which 15 were completed as monitoring wells, three were completed as piezometers, and two were completed as cased boreholes for use in the bulkhead geophysics investigation (discussed in Section 2.1.14).

Of the 65 total soil borings, 28 were advanced for the purposes of TarGOST® profiling (discussed in Section 2.1.3), and 17 borings were advanced to confirm the results of the TarGOST® delineation. The locations of all soil borings are shown in Figure 2-1. All SRI soil borings, including methods used to advance borings, are summarized in Table 2-1. Boring logs for soil borings are included in Appendix C.

Prior to drilling activities, Vargo Associates (a New Jersey-licensed survey firm in Franklinville, N.J.) surveyed the proposed sample locations, as discussed further in Section 2.1.15. SGS Environmental Services, Inc., of West Creek, N.J. (SGS); Environmental Probing Investigations, Inc., of Cream Ridge, N.J. (EPI); and Boart Longyear, of North Reading, Mass. (BL), performed the soil borings and monitored well installations during the SRI activities. Drilling methods involved the use of direct-push (SGS and EPI), hollow-stem auger (EPI), and rotosonic (BL) drilling methods. To accomplish direct-push drilling, a Geoprobe® 6010DT direct-push rig was used by SGS, and a Hurricane hollow-stem auger

rig equipped with a Geoprobe® direct-push hammer was used by EPI. Rotosonic drilling methods were employed at locations where shallow obstructions had historically proven to be an obstacle to continuous soil sampling, where larger-diameter borings were required for the installation of monitoring wells, and where drilling depths near bedrock in the area of the Site shoreline were needed. Both SGS and EPI completed soil borings for soil-sampling purposes, and SGS performed the direct-push drilling to advance the TarGOST® probe. EPI employed hollow-stem auger techniques to install monitoring wells at two locations (MW-128 and MW-129).

Soil samples were collected continuously in 4- or 5-foot intervals depending on the drilling equipment used at a given drilling location. Geoprobe® direct-push technology (DPT) and rotosonic drilled intervals were 5 feet long. Hurricane® DPT drilled intervals were 4 feet long due to the shorter stroke length of the Hurricane equipment. Soil samples were collected using either a clean Geoprobe® direct-push Macro-Core® sampler with a disposable acetate liner or a 5-foot-long stainless-steel core barrel. Sampling and analytical methods were based on the specific objectives for each location. (See Section 2.1.4 for a more in-depth description of analyses performed at each boring.) Clean, disposable Lexan® liners were used for collecting soil samples, using core barrel-sampling methodology, to be analyzed according to the sequential extraction process (SEP). During all borings, soil samples were classified by the onsite CH2M HILL geologist according to the Unified Soil Classification System using the procedures described by ASTM (2000). Soil samples were screened using a photoionization detector (PID) calibrated with to an isobutylene standard of 100 parts per million by volume (ppmv) and a response factor of 1.0. Soil logs containing information about lithology, visual evidence of NAPL and constituents in soil, PID readings, and general drilling conditions were maintained for each soil boring and are presented in Appendix C.

Subsurface obstructions were encountered at TL13.5-10.5 and TL10-11.25 while using the direct-push rig to advance soil borings. In each of these instances, several unsuccessful attempts were made to drill through the obstructions prior to finding successful locations approximately 15 feet away from the proposed locations. After several attempts, both borings were successfully completed to their anticipated depth. Additionally, TL10-07.5, TL11.5-11.25, and TL11-00 encountered subsurface obstructions and were terminated prior to reaching proposed depths. Multiple unsuccessful attempts were made at each of these locations, with each subsequent drilling location being within 2 to 10 feet of the original location. Several macrocore barrels and drill rods were damaged while attempting to penetrate subsurface obstructions near these borings.

Pulverized concrete observed on the downhole tools and pulverized concrete around the borehole suggest that most the DPT refusals were caused by concrete and/or reinforced concrete. However, refusal at TL 11-00 was likely caused by rip-rap boulder(s), which are common in that portion of the former Lever Brothers property. No refusals were encountered during rotosonic or hollow-stem auger drilling.

Forty-two borings, including those for TarGOST® profiling, were advanced using direct-push drilling techniques to a depth of no greater than approximately 3 feet into the top of the silty clay unit or to a depth of refusal (on top of glacial till or bedrock) where the silty clay was not present. Most rotosonic borings were also advanced to a depth of no greater than approximately 3 feet into the top of the silty clay unit, or in the case of shoreline

borings, to the depth of the bedrock or glacial till where the silty clay was generally not present in areas of the bedrock high. The one exception included a soil boring completed along the shoreline (PZ-8), where the silty clay aquitard was present to the south of the bedrock high and confirmation of the top of the bedrock surface required drilling through the deeper silty-clay aquitard and underlying deep sand unit prior to reaching the top of the bedrock. All locations along the shoreline that were drilled to the bedrock surface (including PZ-8) were completed using a multicasing override system to isolate and seal off the shallow water-bearing zone and prevent potential downward migration of groundwater and other substances during and after drilling and well construction activities.

Upon completion of the borings, soil borings that had not been converted into monitoring wells were backfilled with hydrated bentonite chips. The top 6 inches of each abandoned boring was completed with material similar to the surrounding surface (e.g., asphalt, concrete, or gravel). All soil boring and monitoring well locations were surveyed by Vargo Associates for final location data.

Organic Constituents, Metals, PCBs, and Arsenic Solid Phase Association Soil-Boring Advancement

To address the appropriate data objectives, one or more soil samples were collected from 47 soil borings for laboratory analysis. Soil samples were collected from these soil borings for subsequent laboratory analyses to address specific data gaps in the nature and extent of constituents at the Site. The associated soil-sampling activities are described in Section 2.1.4.

At one direct-push boring and nine rotosonic boring locations, samples were collected for arsenic SEP. Following advancement of a soil boring for the purposes of soil descriptions, sampling for organics and metals analyses, and well installation, a second collocated boring was advanced, from which arsenic SEP samples were collected at specific depths based on observations at the initial location. The procedure outlined in Attachment C of the SRI Work Plan was followed for arsenic SEP sampling (CH2M HILL, 2008b).

Shoreline and Wooden Bulkhead Characterization

To refine the current understanding of the distribution of NAPL near the wooden bulkhead, seven soil borings were advanced to depths ranging from 26 to 75 feet bgs with continuous soil sampling, lithologic logging, and visual characterization. Soil borings were advanced in areas immediately behind the bulkhead and just beyond the northern extent of the bulkhead. Subsequently, three soil borings were converted into nested piezometers (PZ-6, PZ-7, and PZ-8), two were converted into permanent monitoring wells (MW-134 and MW-135), and two were converted to cased boreholes for a geophysics survey (BH-1 and BH-2), which is discussed in Section 2.1.14.

The locations of the seven soil borings with continuous soil sampling, PID screening, and visual observations are illustrated in Figure 2-1. These borings allowed for the refinement of the vertical distribution of NAPL relative to the bulkhead structure.

At each of the seven soil-boring locations, rotosonic drilling methods were employed by BL, and all borings, with the exception of MW-134, were advanced through to the top of the bedrock. At each soil-boring location drilled to the surface of the bedrock, the previously discussed multicasing override system was used. MW-134 was not advanced to the top of

bedrock, because of its close proximity to MW-135, and the established objectives of this boring did not necessitate drilling more than several below the fill deposits.

2.1.3 TarGOST® Profiling

Twenty-eight soil borings were advanced using TarGOST® technology with a Geoprobe® Model 6010DT, to further define the distribution of coal-tar NAPL and to determine its presence in specific areas, as outlined in the SRI Work Plan (CH2M HILL, 2008b). TarGOST® is a down-hole, laser-induced, fluorescence-screening tool developed and operated by Dakota Technologies of Fargo, North Dakota. TarGOST® methodology is described in Appendix A. The TarGOST® borings drilled during the SRI are listed in Table 2-2; logs are included in Appendix D. Figure 2-1 shows all TarGOST® boring locations.

During the SRI activities, TarGOST® borings were advanced from August 19 to August 22, 2008, to depths of up to 35 feet bgs. SGS operated the Geoprobe™ 6010 direct-push rig that was used to advance the TarGOST® probe. TarGOST® borings were advanced to depths specified in the work plan to delineate the vertical extent of coal-tar NAPL at each location. As such, the TarGOST® borings were advanced until the TarGOST® equipment indicated that the fluorescence response of the material “at depth” was similar to the background fluorescence response of the material at that location (usually less than 49.1 percent RE, a reference emitter) or until the proposed depth (corresponding to the silty clay or organic silt unit) or refusal was encountered. For locations where the TarGOST® fluorescence response was near background throughout the depth of the boring (i.e., a minimally affected boring), the drilling was terminated at the work plan specified depth.

TarGOST® borings for each property were advanced in locations specified in the work plan and were based on an understanding of the distribution of NAPL and on the need to:

- Define the extent of coal tar NAPL near SB-27 and SB-30
- Determine the extent of NZ-1 and NZ-4 near Blocks 93 Central and South and in the northwestern corner of the Lever Brothers property
- Confirm the extent of coal tar NAPL in the northeastern corner of the Lever Brothers property
- Determine whether NAPL previously observed in soils at the boring for MW-106A was coal tar or some other form of NAPL

A grid pattern established during RI activities and detailed in Appendix A was used to determine where TarGOST® borings would be advanced (CH2M HILL, 2008b). TarGOST® borings were completed within this grid pattern and in the context of the previously mentioned areas. Twenty TarGOST® borings proposed in the SRI Work Plan (CH2M HILL, 2008b) were advanced to a maximum depth of 31 feet bgs across Blocks 93 North, Central, and South, and the northwestern portions of the former Lever Brothers property. Two additional TarGOST® borings were advanced to a maximum depth of 30 feet bgs in the northeastern corner of the former Lever Brothers property near existing monitoring well MW-106A. Seven contingency TarGOST® profile locations were premarked and cleared for utilities prior to mobilization; however only one location, TL09-09 was advanced to 32 feet bgs. An additional, originally unplanned location, TL10-09.5, was advanced in the

northwestern portion of the former Lever Brothers property (in an area that had been shown to be free of subsurface utilities based on the geophysical survey and one-call mark-outs) to a depth of 30 feet following results at nearby borings TL10-09 and TL10.5-09.5.

Based on soil screening, visual observations, and TarGOST® data from the northeast corner of the former Lever Brothers property and near a former aboveground storage tank (AST) of unknown contents, following advancement of TarGOST® borings TL12-.01.5 and TL12-00.5, an additional four TarGOST® borings were advanced. These additional four TarGOST® borings—TL11.25-00, TL11.75-00, TL12.5-00, and TL11-00—were advanced to a maximum depth of approximately 31 feet. These borings were used to evaluate the presence of NAPL previously observed in soil at boring MW-106A, and to determine whether it is either (1) coal tar related to NZ-2, (2) a substance similar to that which was observed as measurable LNAPL at MW-7 (located approximately 100 feet upgradient), or (3) petroleum-related constituents associated with a former AST adjacent to monitoring well MW-106A.

Subsequent to the TarGOST® borings, soil samples were collected for analytical testing at 17 TarGOST® locations using a Geoprobe® direct-push Macro-Core® sampler. In general, confirmatory soil-sampling locations were selected to allow for the collection of additional analytical soil data in areas where the extent of coal tar-related constituents below the applicable soil-screening criteria had not been established or where TarGOST® responses deemed aberrant on the basis of the results of previous subsurface investigations were detected. Confirmatory borings were advanced to an equal depth as compared to the top of the confining unit or to the top of till or bedrock in areas where the confining unit is not present. See Section 2.1.4 for specific details of confirmatory soil samples and parameters for which they were analyzed.

2.1.4 Soil Sampling

When field conditions permitted (i.e., when a sampler could be advanced or recovery was sufficient), soil samples were collected for laboratory analysis from the sample intervals specified in the SRI Work Plan (CH2M HILL, 2008b). The analyses conducted on soil samples collected as part of the SRI are summarized in Table 2-3. Soil boring logs are presented in Appendix C.

In total, 97 soil samples were collected and analyzed as part of the SRI activities; all of which were collected for laboratory analysis and shipped by overnight courier to Accutest Laboratory of Dayton, New Jersey, under executed chain-of-custody forms. Nineteen of these samples were shipped to Applied Speciation and Consulting, LLC, of Tukwila, Washington, for arsenic SEP analyses under executed chain-of-custody forms. Laboratory analytical results from the SRI activities are summarized in Appendices E through K and discussed in Sections 4 through 6.

Organic Constituents and Metals Soil Sampling

Up to three soil samples were collected from each of the following locations: Blocks 93 North, Central, and South; Block 92.01; Block 94; and in the northwestern and northeastern portions of the former Lever Brothers property. Sample depth selections were based upon visual observations, PID screening results, and, where analyzed, TarGOST® response data. Samples were analyzed for Target Analyte List (TAL) metals using EPA method 6010, mercury using EPA method SW7471, volatile organic compounds (VOCs) (including

additional compounds 1,2,4-trimethylbenzene (TMB), 1,3,5-TMB, Acrolein, n-Propylbenzene) by EPA method SW8260, semivolatile organic compounds (SVOCs) by EPA method SW8270, and polychlorinated biphenyls (PCBs) by EPA method SW8082.

In general, at each location, one soil sample was collected from between 0 and 2 feet bgs and a second from the interval between 2 and 10 feet bgs where visual evidence suggested the greatest likelihood of the presence of constituents in soil. If additional evidence of constituents in soil was observed below 10 feet, a third sample was collected from the depth corresponding to those observations. Specifically, depth intervals containing, black or brown cinders, slag material, and/or reddish purple soils were targeted for laboratory analyses.

Consistent with the SRI Work Plan, any soil samples with visual evidence of NAPL collected in the northeastern portion of the former Lever Brothers property (TL12-00.5 and TL12-01.5) were to have been analyzed for total petroleum hydrocarbon (TPH) fingerprinting by EPA method 8100M (CH2M HILL, 2008b). This method was subsequently changed to include gasoline range organics by EPA method SW8015, diesel range organics by EPA method SW8015, and TPH fingerprinting by EPA method SW8015. This modification was implemented because the SW8015 method provided a broader range of results than the 8100M method; in addition, the forensics analysis typically part of the 8100M method was also obtainable through the SW8015 method.

Several deviations were made at two locations in Block 93 South. No sample was collected from the 0- to 2-foot interval at SB-48 because no soil was recovered from 0 to 5 feet bgs owing to the presence of concrete. No samples were collected for analysis from location TL11.5-11.25 because of refusal at ground surface; soil sampling at location TL11-11.75 was substituted. Concrete and/or reinforced concrete likely caused the refusal at TL 11.5-11.25 based on visual observations of down-hole tooling and pulverized concrete around the bore holes attempted in this area.

Some exceptions to these general guidelines were required, according to the SRI Work Plan (CH2M HILL, 2008b). At MW-123, only a sample from the 0- to 2-foot interval was required and collected, but a second, unscoped sample was also collected from 4.0 to 4.5 feet bgs owing to the presence of cinders and an odor. Locations in Block 92.01 and at the intersections of Gorge and Old River Roads and Gorge and River Roads (SB-52, MW-125, MW-126, SB-49, SB-50, and SB-51, and SB-58, last of which was not included in the SRI Work Plan) also had slightly different sample depth requirements. The shallower sample from each of these locations was collected below 2 feet bgs and targeted the interval with visual evidence that suggested the presence of the greatest abundance of constituents in unsaturated soil. The second, deeper sample at each location was collected from the most-impacted saturated soil interval.

Only one sample was required from each of four boring locations on the former Lever Brothers property (TL10-07.5, TL10.5-09.5, TL12-00.5, and TL12-01.5), to be collected from the interval showing the most prevalent impacts. However, no soil samples were collected from location TL10-07.5 owing to very shallow refusal at 5.4 feet during TarGOST® profiling operations. At location TL10.5-09.5, two additional samples were collected because of potentially stained soil at 9 to 10 feet bgs and a high TarGOST® response at 23 to 24 feet.

At TL12-00.5, two samples were collected; the second intended to address odor and potentially stained soil at 17.5 to 19.5 feet bgs.

Some additional unplanned samples were collected for analysis from several locations to meet project objectives. A surface soil sample, SS-58, was collected at Block 93 Central. A sample at boring PZ-7 was collected from 16 to 16.5 feet bgs for VOC (including the additional compounds 1,2,4- TMB, 1,3,5-TMB, Acrolein, n-Propylbenzene) and SVOC analysis to address whether organic rich silt encountered at this location and at BH-1 were impacted by NAPL.

Additional unplanned soil borings, collocated with TarGOST® borings, were completed. To aid in defining the nature and extent of coal tar and other types of product in the area, three samples were collected among locations TL11.25-00, TL11.75-00, and TL12.5-00 at the northeastern corner of the former Lever Brothers property. Additional sampling was also performed at the western edge of the former Lever Brothers property. To address product globules observed at 5.9 to 10 feet bgs that did not elicit an elevated TarGOST® response, a sample was collected at TL10-09.5 at 6.5–8.5 feet bgs. Because of shallow refusal at TL10-07.5 and to obtain data at the western edge of the former Lever Brothers property, three samples were collected from contingency boring TL09-09.

On Block 93 South, four additional samples were collected at locations TL09.5-11.25 and contingency boring TL08.5-10.5. At TL09.5-11.25. These samples were collected to address high TarGOST® responses at this location at the respective sampling depths. Sampling performed at TL08.5-10.5 was performed to obtain data at the far southern end of Block 93 South.

Arsenic Solid Phase Association Sampling

On three separate transects representing groundwater flow paths from suspected arsenic source areas, 19 samples were collected among 10 soil boring locations and analyzed using a five-step SEP, which includes analyzing solubilized iron within the extracts. From each boring location, with the exception of MW-133, two soil samples (a “shallow” sample and a “deeper” sample) were collected for SEP analysis. All sample depths were chosen to be from saturated soils within the elevation interval that corresponds to the saturated screen interval of the closest upgradient monitoring well(s) with the highest historical concentrations of arsenic in groundwater. Samples were collected within these screened intervals across the 2-foot span with indicators of arsenic-containing materials, such as slag, cinders, coal, or reddish-purple soils. If no visual impacts were noticed, samples were collected from the midpoint of the intervals specified in the SRI Work Plan (CH2M HILL, 2008b).

Exceptions to specific planned depth intervals outlined in the SRI Work Plan (CH2M HILL, 2008b) occurred. At MW-126, the shallow sample depth was changed from a planned depth of between 4 and 10 feet bgs to an actual depth of 11 to 11.5 feet bgs. A depth of 10 to 11 feet bgs was targeted after observing slag within this interval; however, poor recovery at 10 to 11 feet bgs prompted sample collection to occur at 11 to 11.5 feet bgs.

At location MW-133 at the former Celotex property, only one sample was collected for analysis because bedrock was encountered at 13.8 feet bgs, which was shallower than the anticipated depth for the deep sample of 17 to 18 feet bgs.

At location MW-130, the shallow sample was collected at 16 to 17 feet bgs instead of within the planned 5- to 15-foot bgs interval; this change was due to the presence of concrete and wood from 5 to 15 feet bgs.

One sample for SEP analysis at location SB-54 was collected from 10.25 to 10.75 feet bgs, deeper than the planned depth of 4 to 10 feet bgs because a more representative sample depth was chosen from the middle of an interval containing reddish-purple soils.

Samples for arsenic by EPA method 6010 and for TOC by EPA method SW9060 were collected at each anticipated depth at which a sample for SEP analyses was collected. Because samples for arsenic and TOC were collected in borings in advance of the adjacent borings at which SEP sampling occurred, and because site conditions led to SEP depth changes, as detailed above, the depths for the arsenic-TOC samples and the arsenic SEP samples were sometimes not identical. Sixteen samples from nine locations were collected and analyzed for arsenic and TOC.

2.1.5 Permanent Monitoring Well Installation

Fifteen soil borings were converted to permanent groundwater-monitoring wells with depths ranging from 10 to 30 feet bgs. These monitoring wells were drilled using rotasonic drilling techniques and are referred to as MW-123 through MW-130A and MW-130B, and MW-131 through MW-136. Each well was constructed either as a 2-inch- or 4-inch-diameter polyvinyl chloride (PVC) monitoring well with a 0.020-slot, 10-foot-long screen with a 2-foot sump; however, two locations (MW-133 and MW-136) were constructed with a 5-foot-long screen.

All monitoring wells, with the exception of MW-135, were screened within the unconfined groundwater zone. The well screen at MW-135 straddles the unconfined aquifer and the underlying organic silt unit. One location, MW-130B, was screened at the base of the unconfined groundwater zone. A 2-foot-long sump was added to each well for the purpose of capturing NAPL in the shallow unconsolidated unit. Characteristics of permanent monitoring wells are summarized in Table 2-4. Figure 2-1 depicts the location of each monitoring well. Monitoring well construction logs are presented in Appendix C.

Of the 15 monitoring wells, four were installed within Block 93 Central and South, four were installed within the former Lever Brothers property, three were installed within the former Celotex property, one each was installed at the intersections of Gorge and River Roads and Gorge and Old River Roads, and two were installed within Block 94. All newly installed monitoring wells, including those that contain NAPL, were sampled as part of the semiannual groundwater-sampling events, as discussed in Section 2.1.8.

Monitoring Well Development

Development of the newly installed wells occurred from October 21 to November 7, 2008, and from February 27 to March 3, 2009. All wells were developed using surge-and-purge methodology according to EPA (1992) guidelines. Well development procedures were identical to those used during the RI/FS activities and are detailed in Appendix A. Monitoring well completion reports and NJDEP Form Bs are included as Appendix L. Development water was contained in 55-gallon drums and was staged on the Quanta property for future offsite disposal.

2.1.6 OU1 Shoreline Piezometer Installation

Three of the soil borings immediately adjacent to and west of the wooden bulkhead that were installed using roto sonic drilling methods were subsequently converted into nested piezometers (PZ-6, PZ-7, and PZ-8) shown on Figure 2-1. Nine piezometers in three piezometer nests were installed along the shoreline adjacent to the wooden bulkhead at varying depths within OU1. At each OU1 piezometer nest location three piezometers with discrete 2-foot-long screens were installed within drilled boreholes to depths of approximately 10 to 58 feet bgs. Each piezometer consisted of 2-inch- or 1-inch-diameter PVC with a 2-foot-long 0.020-slot screen with an appropriate sand pack and seal. Following installation, all OU1 piezometers were developed with methodology discussed in Section 2.1.5. Piezometer construction detail is summarized in Table 2-4, and piezometer construction logs are presented in Appendix C.

2.1.7 OU2 Piezometer Installation

Nested drive-point piezometers were installed in five locations at varying depths within OU2 sediments to collect pore water samples and hydraulic head information downgradient of OU1. Figure 2-1 shows the locations of these piezometer nests (PZ-1, PZ-2, PZ-3, PZ-4 and PZ-5). At each of the five locations, three drive-point piezometers were installed to various depths. Table 2-4 provides final construction details for each piezometer. Locations were chosen to provide data in nearshore areas downgradient of the Quanta property as well as to the north and south.

On October 15 and 16, 2008, five of 15 OU2 piezometers were installed, at locations PZ-5S, PZ-5I, PZ-5D, PZ-3I, and PZ-3D. Drive points consisted of Solinst® model 615S stainless steel threaded drive points with 1-foot-long mesh screens and expendable shields. Drive points were constructed with barb fittings to which Teflon®-lined tubing was attached and subsequently strung through ¾-inch threaded black steel pipe (3- or 6-foot-long sections). Each point and its associated pipe extensions were pushed by hand to a depth of approximately 15 feet below sediment surface (bss) and, if necessary, driven to completion (up to 25 feet bss) depth using a slide hammer and or an electric hammer. The full length of pipe and screen were then pulled back 1 foot to allow the expendable shield to fall away, exposing the piezometer screen.

PZ-3I, PZ-3D, and PZ-5D required limited development to remove sediments that were smeared on the screens and enhance the connection between the piezometers and the adjacent pore water. The development was performed by pumping deionized (DI) water into and out of the piezometers using a peristaltic pump and then monitoring the pore water levels before and after using a water level indicator. Based on the pre- and post-development water level measurements, pore water levels indicated that development efforts at PZ-3M and PZ-3D were successful (e.g., the volume of DI/pore water removed from the piezometer was greater than the volume within the piezometer, and pore water recharge was observed. PZ-5D was significantly slower to recharge, and took almost 1 month before fully recovering. At each piezometer that was developed, DI water that had been injected into piezometers was pumped out until formation water was observed in the purge stream or until an equivalent volume of water was removed. All piezometers were allowed to sit for approximately 1 month prior to initiation of the shoreline hydraulic head monitoring (Section 2.1.10). Only

hydraulic head data collected at these locations after full recharge had occurred were used in SRI hydraulic data evaluations.

Owing to the complications associated with the smearing of select drive point screens, the remaining 10 of 15 OU2 piezometers were installed using Geoprobe® rods and tooling. Drive points consisted of Geoprobe® model AT8625S wire mesh stainless steel screens, 6 inches long, attached at the bottom to an expendable drive point. One-inch-diameter Geoprobe® rods and a drive point were advanced to a predetermined depth using a slide hammer. A screen was then attached to ¼-inch Teflon® tubing, inserted through rods, and threaded into the expendable drive point. Rods were then retracted, exposing the screen to the sediment. This approach eliminated screen movement after advancement, thereby avoiding any sediment smearing. Black steel pipe was inserted over the tubing several feet into the sediment to serve as a protective surface casing. Final installation depths for each piezometer are provided in Table 2-4.

2.1.8 Semiannual Groundwater Sampling

According to the SRI Work Plan (CH2M HILL, 2008b), two semiannual groundwater-sampling events were required. The first involved collecting groundwater samples from newly installed wells and a specified subset of the existing monitoring wells. This event took place between December 1, 2008 and January 19, 2009, and on March 18, 2009. Fifty-one monitoring well locations were sampled as described in the SRI Work Plan (CH2M HILL, 2008b).

A summary of the wells sampled for semiannual groundwater-sampling event, data quality objectives and analytical parameters for each well included in the first event are provided below and in Table 2-5.

The second groundwater sampling event is scheduled to take place in September 2009.

Groundwater-Sampling Equipment and Procedures

Groundwater purging and sampling was conducted according to the techniques described in Appendix A (field sampling plan) of the original RI/FS Work Plan (Parsons, 2005) and in the SRI Work Plan (CH2M HILL, 2008b). After a comprehensive round of water level measurements was performed (as described in Section 2.1.9) and prior to sampling, the monitoring wells were purged using low-flow-sampling techniques (EPA, 1998) to minimize turbidity and to collect samples representative of formation conditions.

Purging and sampling were performed consistently with the methodology employed during the RI/FS activities, as detailed in the RI Report (Appendix A). An exception was a subset of 21 of the 51 total wells sampled for arsenic III and V speciation during the first semiannual event. Specialized equipment and procedures were required for filling the sample bottles to preserve the oxidation state of the sample. Details on this sampling procedure are included in Appendix C of the SRI Work Plan (CH2M HILL, 2008b).

Decontamination procedures are provided in Section 2.2, and investigation-derived waste (IDW) management procedures are provided in Section 2.3. Groundwater sample analytical methods and specifics are described below.

Groundwater Sample Analytical Methods

The analyses performed on groundwater samples collected during the first of two semiannual monitoring events are specified for each location in Table 2-5. This sample list includes those collected from newly installed wells and the subset of previously existing monitoring wells. Details regarding the required containers, preservatives, and holding times for groundwater samples are listed in the field sampling plan (Parsons, 2005).

Groundwater samples were collected from 51 wells during the first semiannual groundwater-sampling event, which occurred from December 1, 2008, through March 18, 2009. Samples from all locations were analyzed for total and dissolved TAL metals, each by EPA method 6010B, additional major ions (sulfate, sulfide, nitrate, and chloride by EPA method 300.0 and total phosphorous by EPA method 365.3), alkalinity by EPA method SM2320B, and dissolved organic carbon by EPA method 9060. Samples were collected from 40 monitoring wells across all properties (including the newly installed wells) and analyzed for VOCs by EPA method 8260 and SVOCs by EPA method 8270. Samples collected from newly installed wells were also analyzed for PCBs by EPA method 8082.

A subset of the 51 wells sampled during the first semiannual groundwater-sampling event was also sampled for arsenic III and V speciation using an NJDEP-approved ion chromatography method. Locations of the monitoring wells sampled are illustrated in Figure 2-1. With the exception of the samples that were collected for arsenic III and V speciation during the first semiannual event, all groundwater samples were collected using the equipment and procedures previously employed at the site as part of RI/FS groundwater-sampling activities and as described in detail in Appendix A of the original field sampling plan (Parsons, 2005) and as described above in the “Groundwater-Sampling Equipment and Procedures” subsection.

Quality assurance/quality control (QA/QC) samples were collected in the frequency and the manner specified in the revised quality assurance project plan (QAPP) (CH2M HILL, 2005, 2006, 2008d). Samples were transported overnight by courier to the laboratory under standard chain-of-custody protocol. Accutest Laboratories of Dayton, New Jersey, performed most of the analyses for the semiannual groundwater-sampling event. The arsenic III and arsenic V speciation analysis was performed by Applied Speciation and Consulting, LLC, of Tukwilla, Wash., and these samples remained on ice until several samples accumulated throughout a week, after which time samples were shipped overnight. Sample handling, labeling, packaging, and shipping were performed according to the procedures identified in Section 7 of the original field sampling plan (Parsons, 2005).

A summary of groundwater analytical results can be found in Appendixes M through R. The in situ stabilization parameters are summarized in Table 2-6.

2.1.9 Sitewide Synoptic Events and Product Thickness Measurements

Two synoptic water level events and one product thickness measurement event were conducted at all newly installed and existing monitoring wells that have historically been measured during prior synoptic events. The first event occurred on November 25, 2008, before the first semiannual groundwater-sampling event. However, due to the subsequent installation of wells MW-128 and MW-129, a second synoptic water level event, to include these two wells, was conducted on March 17, 2009. A full round of product thickness

measurements was conducted in November 2008; product thickness measurements were collected at MW-128 and MW-129 in March 2009. Product thickness measurements involved gauging for the presence of both LNAPL and DNAPL within each well. In addition, depth-to-water measurements were recorded prior to developing and sampling each monitoring well.

Groundwater gauging was performed during mid-tide conditions over approximately 4 hours. Each survey was conducted by measuring water levels with an electronic oil-water interface probe or an electronic water level indicator. In general, depth to water and NAPL measurements were taken from the top of the inner casing. Simultaneous measurements were performed by three field personnel by collecting measurements at a predetermined time in separate portions of the near-shoreline portion of the Site. Measurements were collected first at wells closest to the Hudson River and progressed west across the site. The procedure for measuring groundwater levels and product levels detailed in Section 4.2 of the original field sampling plan (Parsons, 2005) was followed. Synoptic water level data from both events is included in Table 2-7.

LNAPL gauging was performed using an oil water interface probe during the collection of depth-to-water measurements. At wells where LNAPL was encountered, the water level indicator would not sound until after the water level probe was lowered through the LNAPL interval to the depth of the groundwater/LNAPL interface. Because of the physical characteristics of the LNAPL, a smear of LNAPL thickness remained on the water level indicator probe and tape (if the thickness was great enough) after removing the probe from the well. The thickness of the LNAPL staining was measured and recorded. LNAPL was observed in only two monitoring wells measured during the November 25, 2008, synoptic depth-to-water measurement event. Well MW-7 was observed to have approximately 0.20 foot of LNAPL, and well MW-105A was observed to have approximately 0.31 foot of LNAPL. A summary of NAPL observations for wells, as recorded during the SRI is included in Table 2-8.

Measurements of DNAPL thickness were collected using one of two methods. The first method involved slowly lowering the oil-water interface probe into the monitoring well until the probe indicated the presence of DNAPL or the bottom of the monitoring well was encountered. If DNAPL was present, the initial depth at which the probe indicated a change from water to DNAPL was measured from the top of the inner casing. The initial interface depth at which the DNAPL was encountered was recorded and subtracted from the total depth of the well, to obtain the thickness of the DNAPL.

The second method was performed by observing the DNAPL coating on the oil-water interface probe or a bailer. Because of the viscosity of the DNAPL at some locations and its immiscibility with water, DNAPL smearing on the outside of the bailer could make obtaining accurate DNAPL measurements using a bailer difficult. Therefore, the preferred method of observing DNAPL thickness in the monitoring wells was measuring the total length of the DNAPL coating the interface probe and measuring tape.

2.1.10 Shoreline Hydraulic Head Measurements

Six hydraulic head measurements were collected over both high- and low-tide conditions over approximately one week. Measurements were obtained between December 5 and 7 and between December 11 and 13, 2008. Each survey was conducted by measuring water

levels with an electronic oil–water interface probe or an electronic indicator for the water level. A ¼-inch-diameter electronic water level probe obtained measurements from small-diameter OU2 piezometers. In general, depth-to-water measurements were taken from the top of the inner PVC well riser or inner casing and, in the case of the OU2 piezometers, at the top of the Teflon®-lined tubing at the top of each location. NAPL measurements were not collected during these hydraulic head measurement rounds.

Hydraulic head information was collected from wells along the shoreline portion of OU1 and in the immediate vicinity of the bulkhead to understand the groundwater flow paths between OU1 and the possible groundwater discharge areas at OU2. For all six events a subset of monitoring locations prescribed in the approved work plan that included all nearshore monitoring wells, the existing staff gauge within the Hudson River, as well as a number of wells farther inland were measured in conjunction with all OU2 piezometers. Additional measurements were collected at the PZ-5 cluster on January 5, 2009. When time permitted, water levels were collected from a number of additional inland wells not originally included in the work plan to augment data collected from the core measurement locations, provide higher data resolution, and potentially assist in data interpretation.

During each tidal event, shoreline water level measurement events commenced approximately 1 hour prior to the high or low tide event and concluded approximately 1-hour after the tidal peak. During high-tide events, a jon boat was deployed, and two CH2M HILL staff collected offshore piezometer measurements at clusters PZ-1, PZ-4, and PZ-5. During low tide, these locations were accessed across the mud flat area by a temporary walkway constructed of 3- by 8-foot polyethylene mats.

Hydraulic head measurements collect during the shoreline events at monitoring wells and piezometers at the site are summarized in Table 2-9. Hydrographs for each OU2 piezometer cluster are presented in Figure 2-2.

2.1.11 OU2 Piezometer Sampling

When conditions permitted, deeper pore water samples were collected from the OU2 drive point piezometers. At a number of locations sample volumes sufficient to satisfy the laboratory's minimum requirements for one or more parameters could not be obtained due to the low-yielding sediment matrix within which they were screened. Table 2-5 lists the OU2 piezometers that were sampled and the analyses that were conducted on each pore water sample:

- Piezometers were accessed either from the concrete overhang along the eastern edge of the Quanta property or by using a temporary walkway, constructed of 3- by 8-foot polyethylene mats during low-tide conditions when the nearshore mudflat was exposed.
- Depth to water was measured inside the Teflon tubing within each piezometer using a ¼-inch electronic water level probe. Notations were made if NAPL was observed on the water level probe.
- Pore water was purged using a peristaltic pump and dedicated polyethylene tubing. Piezometers were pumped dry in most cases prior to sampling because three well volumes were not yielded, as normally required. Subsequent pore water recharge of the

well was sampled. Flow-through cells were not able to be used due to the insufficient water volume available at most piezometers.

- Pore water samples were collected for the analysis of VOCs by EPA method 8260, SVOCs by EPA method 8270, and total and dissolved arsenic, each by EPA method 6010B, according to the specifications in the revised QAPP (CH2M HILL, 2005, 2006, 2008d). Owing to very low yield from most locations and the resulting small quantities of water available, only a fraction of the required sample volume was able to be collected. Only three locations—PZ-2D, PZ-4S, and PZ-4I—yielded enough water for all analyses. Table 2-5 shows which analyses were actually able to be conducted per location.
- One-sixteenth-inch-diameter tubing used to sample piezometers when sampling directly from the piezometer riser tube was not successful. During the January 2009 sampling event water in the small-diameter tube was frozen, so sampling was delayed until March 2009, when weather conditions improved. Low yield from many locations prevented the collection of full suites of analyses.

2.1.12 DNAPL and LNAPL Sampling

NAPL samples were collected from three monitoring wells to determine the composition of NAPL material in portions of the Site where the characteristics of NAPL had not previously been determined during the RI. This information was used to supplement data previously collected during the RI, as detailed in Appendix A.

A sample was collected from MW-105A, which was installed during the RI, and where 0.3 foot of LNAPL was observed during the SRI. Previously, a recoverable or collectable amount of LNAPL had not been observed there. In addition, DNAPL was collected from two monitoring wells that were installed as part of the SRI, MW-135 and MW-123. DNAPL from MW-135 was sampled to characterize the chemical and physical properties of material present along the shoreline area in NZ-5. At MW-123, DNAPL sampling was performed to characterize the properties of NAPL in NZ-4.

The collection of DNAPL samples involved the following procedures:

- Plastic sheeting was laid down around the well to prevent DNAPL from accidentally being spilled onto the ground surface. Wells were gauged to determine how much DNAPL was in the wells prior to sampling, as detailed in Section 4.2 of the original field sampling plan (Parsons, 2005).
- DNAPL samples were collected using dedicated, weighted Teflon® bailers, and product was poured from the bailer into 1-L amber jars for analysis. If the amount of product retrieved was insufficient to fill a 1-L amber jar, the jar was labeled, and the well was revisited at a later date to continue sampling. In between DNAPL collection attempts, the partially filled jar of DNAPL was sealed and stored in the onsite field trailer.
- Approximately 90 percent of the sample in the jar was DNAPL, with the remaining volume being water.
- A separate COC was filled out and proper hazardous material shipping instructions were followed for delivery to the laboratory. NAPL samples were shipped under executed chain-of-custody forms to META Environmental, Inc., for analysis.

LNAPL sampling procedures and analytical parameters were identical to those involved with DNAPL sampling except that a bailer was used in a different manner to collect the LNAPL samples. During LNAPL sampling, bailers were used as a surface for the LNAPL to adhere to and be collected from since the LNAPL could not be contained within the bailer during its extraction from the well. To collect the LNAPL sample, the bailer was lowered into the LNAPL interval then removed from the well where the LNAPL was allowed to drip into the sample jar. This process was repeated many times to obtain a sample volume sufficient to perform the required analyses. A summary of the chemical and physical parameters for which the NAPL portion of each sample was analyzed for as well as the specific analytical methods that were used is provided in Table 2-10. Prior to chemical analyses, all samples were prepared by waste dilutions (EPA method 3580) using dichloromethane. Table 2-11 summarizes the analyses performed on all NAPL samples, and results are discussed in Section 4. Appendix S provides the reports that META prepared for results of the three NAPL samples collected, and Appendices T and U include data tables of these results.

2.1.13 Trident Probe Survey with Pore Water and Surface Water Sampling

The objectives of the Trident Probe survey were to identify potential groundwater discharge zones in the Hudson River adjacent to OU1 and to collect shallow pore water and surface water samples at these potential discharge zones. It should be noted that the purpose of the Trident probe pore water sampling was different from the piezometer pore water sampling. The Trident pore water sampling was performed to determine the concentrations of constituents near the shallow, biologically active zone of the sediments in areas most likely being affected by groundwater upwelling. In contrast, samples of deeper pore water from the OU2 piezometers were collected to help understand the distribution of constituents along the flow paths between OU1 and the shallow pore water. The following section presents a summary of the field methodology. Additional detail on the groundwater upwelling survey and Trident Probe pore water sampling is presented in the final report submitted by Coastal Monitoring Associates (CMA) in Appendix V.

A Trident Probe sensor survey was conducted between July 14 and July 16, 2008. The Trident Probe (Figure 2-3) is a direct-push, integrated temperature sensor, conductivity sensor, and pore water sampler developed as a screening tool that may be used to determine if and where groundwater may be discharging to a surface water body (Chadwick et al., 2003). As part of the OU1 SRI, the Trident probe was inserted into the river bed to a depth of approximately 2 feet at 55 locations (Figure 2-4). At each location, conductivity and temperature data were collected from the probe (subsurface) and from the surface water approximately 1 foot above the sediment-surface water interface. Once the sensor readings stabilized, the data were recorded electronically. The data were then mapped to evaluate the most likely areas of groundwater discharge based on spatial patterns of subsurface conductivity, and secondarily, temperature. (Figure 2-5). The sensor data mapping was used to select the five locations from which pore water samples were collected for chemical analysis.

Subsurface bulk conductance data are expected to more closely differentiate between subsurface sediment affected by upwelling lower conductance groundwater than that which is not and is more strongly influenced by the overlying saline (higher conductance) river

water. Potential groundwater discharge zones were selected based on a statistical analysis of the bulk conductance data collected by the Trident probe in the subsurface. The conductivity data collected from the river water were compared to the subsurface conductivity data. Section 3.3.3 has a more detailed discussion of these data. Zones of lower conductivity and temperature do not necessarily represent areas of constituent flux. Characterization of constituent concentrations in pore water and surface water conditions at these locations is required to determine where the flux of Site constituents may be occurring at OU2. The Trident pore water sampling event was conducted from July 17 through July 25, 2008. Pore water samples were collected at five stations (Figure 2-5). For pore water sampling, two Trident probes were configured with five pore water samplers set to a sampling depth of 12 inches below the sediment surface, to maximize flow rate and sample volume as a function of time. The samplers were fully inserted into the sediment with a 1-inch-diameter sand pack surrounding each sampler, and pore water samples were collected from the samplers through foil-wrapped, precleaned 1/8-inch inside diameter Teflon® tubing using a low-flow peristaltic pump. The samplers were purged until water quality parameters stabilized, a minimum of 50 mL (more than three purge volumes) prior to the collection of the actual samples. Following sample collection at each station, the sand pack on each sampler was repacked with clean sand (approximately 60 cm³), and the sample tubing was replaced with new tubing prior to sampling at the next station. Pore water samples were submitted for the following analyses: VOCs by EPA method SW8260, SVOCs by EPA method WS8270, total and dissolved metals, including arsenic by EPA Methods SW6010 and SW7470, and arsenic speciation by EPA Method 6800. Accutest (Dayton, N.J.) performed the VOC, SVOC, and total and dissolved metal analyses; Applied Speciation and Consulting, LLC (Tukwila, Wash.), conducted the arsenic speciation analyses. The pore water aliquot for SVOC analysis from location GWZ-2 was broken during laboratory processing; therefore, SVOC data from this sample are not available.

Pore water samples were analyzed onsite for temperature, conductivity, total dissolved solids (TDS), pH, and oxidation reduction potential (ORP) using a Myron model 6B water quality analyzer. Note that pore water conductivity measurements (Table 2-12) are not directly comparable to Trident subsurface bulk conductivity sensor measurements (Table 2-13). The subsurface conductivity probe measures bulk conductance, and is thus influenced by both the pore water and the sediment. The pore water measurements measure only the conductance of the water. The bulk readings are generally lower because of the influence of the sediment. The two measurements are generally related, but differences in the relationship depend on the porosity and clay mineral content of the sediment.

Collocated surface water samples were also collected at each pore water sampling location and submitted for VOC, SVOC, and total and dissolved arsenic analyses by the same methodology as that used for the pore water samples.

2.1.14 Geophysical Survey

Hager-Richter Geoscience, Inc. (Hager-Richter), of Fords, N.J., conducted both a site surface and down hole geophysical investigation to evaluate the dimensions and characteristics of the known wooden bulkhead along the shoreline and to assess the presence of other possible landward bulkheads or former subsurface shoreline features. The surface geophysical techniques that were used included frequency domain electromagnetic

induction (EM31), time domain electromagnetic induction (EM61), two-dimensional resistivity profiling, ground-penetrating radar (GPR), and precision utility locating. Following the surface geophysics, a downhole parallel seismic survey was conducted inside cased boreholes adjacent to the wooden bulkhead. The final reports from Hager-Richter, which include an expanded discussion of field methods, are included as Appendix W. Figure 2-6 details the specific onsite areas on which work was performed. Section 3.2.2 discusses the results of the geophysical survey.

2.1.15 Site Survey

Surveying tasks were completed by New Jersey-licensed surveying subcontractor Vargo Associates. The purpose of the survey was to fix the lateral location and elevation of boring and wells relative to the New Jersey State Plane Coordinate System (NAD 1983) and the North American Vertical Datum (NAVD 1988), respectively. Vargo also completed documentation of the monitoring well surveying, as required by NJDEP.

In addition, Vargo performed a topographical survey of OU1, along with a mapping of surficial features, including, but not limited to, tree lines, fences, roadways, building locations, light posts, and observable at-grade evidence of existing utilities, such as covered manholes. This survey was based upon aerial photography and conventional ground surveying methods. A site map also displaying the New Jersey Tidelands Claim Line and property boundaries, as based upon the most current tax assessment maps, was generated. Elevation contours were shown at one-foot intervals. During the survey conducted following subsurface activities, a pipe outlet at the shoreline just north of the Quanta property was surveyed as well.

2.2 Field Decontamination

Decontamination was performed to prevent the movement of contamination from one portion of the Site to another and to avoid cross-contamination of samples during the course of field activities. When performing rotosonic or hollow-stem auger drilling, the drill rig was steam cleaned before to, and after, each use at each monitoring well or boring location at a decontamination pad near the center of the site. A pump was used to transfer the decontamination water that collected in the decontamination pad into 55-gallon drums. When using direct-push drilling, all downhole tools were scrubbed between uses with Alconox® and potable water and then rinsed with potable water. Wash water that was generated during decontamination of the direct-push drilling equipment was emptied daily into 55-gallon drums.

Decontamination of non-dedicated and non-disposable sampling equipment was conducted in buckets on plastic sheeting. Sampling equipment (e.g., Grundfos® and QED pumps and water quality probes) were decontaminated thoroughly each day before use (“daily decon”) and after each well was sampled (“between-well decon”), as outlined in Section 3.2.4 of the original field sampling plan (Parsons, 2005). Sampling equipment was wrapped in aluminum foil for storage or transportation from the designated decontamination area to the sample locations.

2.3 Management of Investigation-Derived Waste

IDW generated from SRI field activities was managed and disposed of according to applicable federal, state, and local regulations. Types of IDW generated included soil, groundwater, sediment, NAPL, and disposable sampling equipment. CH2M HILL containerized solid and liquid IDW generated during the RI field activities. Clean Harbors, under contract with Honeywell, performed the IDW characterization and removed the waste in drums from the site.

IDW was contained in Department of Transportation–approved 55-gallon, open-top steel drums. The exception was sampling equipment that was not contaminated with NAPL, which was contained in plastic bags and disposed of as solid waste. Upon placement of material within a drum, the drum was labeled with the type of media it contained, location of origin of the media, and date of waste generation. The labeling of waste containers prior to offsite transportation was performed according to 49 CFR 172, 173, and 178. Drums were staged on the Quanta property, within a fenced area near the gate opening onto River Road, to maintain security and aesthetics prior to offsite disposal.

Clean Harbors determined the hazardous waste characteristics of the generated IDW as required by NJAC 7:26G–6.2 and 40 CFR 261. Waste characterization information was documented on waste profile forms prepared by Clean Harbors. In accordance with 40 CFR 265, hazardous wastes were removed from the property within 90 days of generation. Each load of waste material had a manifest prepared prior to leaving the property. Hazardous wastes were sent to Clean Harbors El Dorado, LLC, in El Dorado, Arkansas, a RCRA Subtitle C treatment, storage, or disposal facility. Nonhazardous wastes were disposed of at Clean Harbors Chattanooga, LLC, in Chattanooga, Tennessee, a Subtitle D facility or a municipal landfill, as appropriate.

2.4 Database Management, Data Validation, and Data Evaluation

Throughout the investigations, the project analytical database was carefully managed and validated. Laboratory data quality assurance/quality control procedures are detailed in Appendix X. Historical data for adjacent properties were obtained and evaluated as both part of the RI and SRI Report for usability. Laboratory quality control data were used for judging usability, in consideration of laboratory reports.

All analytical data collected to date were validated following the process outlined in the QAPP. The analytical data were reviewed according to EPA guidelines for organic (EPA, 2001) and inorganic (EPA, 2004) data review and EPA SW846 methodology. Quality control criteria were evaluated for all samples as appropriate for each analytical method, such as laboratory blanks, field blanks, field duplicates, laboratory duplicates, matrix spikes and matrix spike duplicates, holding times, and sample preservation. The full list of validation criteria is detailed in Appendix X. An overall evaluation of the data indicates that the sample handling, shipment, and analytical procedures have been adequately completed, and that the analytical results should be considered accurate.

Appendix X also outlines specific procedures followed in the areas of data collection and tracking, laboratory analysis, data loading, electronic data deliverable verification, data verification and validation, and data visualization and analysis.

SECTION 3

Site Characteristics

Data collected as part of the SRI provides additional insight into the Site geologic and hydrogeologic settings and the role of the wooden bulkhead present along the downgradient edge of OU1. These data have been used to refine the geologic and hydrogeologic conceptual models that complete the understanding of the nature and extent and the fate and transport of Site constituents in both soil and groundwater and directly address components of SRI Objectives 1, 4, 7, and 8. These objectives were detailed in the approved SRI Work Plan and are summarized below:

- Determine the nature and extent of NAPL and coal tar constituents near Block 93 and the northwest portion of the former Lever Brother's property and in the intersection of Gorge and River Roads (Objective 1)
- Determine the dimensions of the wooden bulkhead and its role in limiting NAPL migration (Objective 4)
- Confirm distribution and mobility of arsenic in groundwater within and downgradient of suspected source zones at OU1 (Objective 7)
- Characterize the groundwater flow paths, distribution, and fate and transport of NAPL and coal tar constituents (VOCs and polycyclic aromatic hydrocarbons (PAHs)) across the GW/SW transition zone(s) between OU1 and OU2 (Objective 8)

This section presents the relevant data collected as part of the SRI and serves to update the discussions of Site geology and hydrogeology presented in Sections 3.2 and 3.3 of the final RI Report (CH2M HILL, 2008a). New information concerning the wooden bulkhead as well as adjustments to the previous understanding of geologic and hydrogeologic characteristics is highlighted.

3.1 Geology

On the basis of additional stratigraphic information collected as part of the SRI as well historic geotechnical boring logs from 11 soil borings completed on the shoreline area of the former Lever Brothers property by Chas T. Main Engineering and Stone & Webster Engineering Corporation (Appendix Y), descriptions of the sitewide stratigraphic setting and the stratigraphy along the shoreline area at the site have been revised and are provided in the following sections. Although the collection of stratigraphic information from borings completed during the SRI was not the primary objective, refinements in the understanding of site stratigraphy provide further information on the architecture of key stratigraphic interfaces that play a part in controlling NAPL mobility as well as dissolved phase transport in water-bearing units, such as the fill and native sand where constituents have been detected in groundwater at concentrations above EPA and state screening criteria. Additional data on the depth and thicknesses of both the unconsolidated and bedrock units

will be used to assess the viability and effects of various remedial options for OU1 during the remedy selection process and part of remedial design.

3.1.1 Refinements to Sitewide Geology

Unconsolidated deposits at OU1 are composed of several key stratigraphic units that were identified and described in detail in the RI Report. Recently collected data have resulted in further refinement of these units. Specifically, additional shoreline borings completed to the top of bedrock have shown that soft organic silts directly beneath the fill near the shoreline are not the same as the silty-clay deposits that are at consistently deeper elevations beneath native sand deposits within the central and southern portions of the site. Historical geotechnical boring logs from the area near the shoreline (Appendix Y) and the boring log for the shoreline SRI boring completed at PZ-8 (Appendix C) show the presence of the organic silt and the silty-clay as distinctly different units separated by native sand deposits. The silty-clay deposits are found at shallower depths toward the west, whereas the soft organic silts are not present there. Furthermore, continuous sampling has revealed the presence of thin layers of dense glacial till at the base of the unconsolidated deposits overlying the bedrock.

Cross sections showing the revised understanding of site stratigraphy are provided as Figures 3-1 through 3-7. The location of each transect is shown in plan view in Figure 3-8.

The characteristics of these units, along with those originally identified in the RI Report, are described below, in order of shallowest to deepest.

- **Fill material.** Up to 35 feet of fill material consisting of a mixture of gravel, sand, and silt with brick, wood, concrete fragments, coal, cinders, and slag.
- **Peat/clayey peat.** Up to 25 feet of organic peat or “meadow mat” with varying amounts of clay, fine sand, and silt. This unit is the “salt marsh peat” that is present in portions of the estuarine and salt marsh deposits depicted by Stanford (1993). The peat/clayey peat deposits are discontinuous and have been observed primarily in borings completed near River Road, Block 93, and the former Lever Brothers property.
- **Soft organic silt.** Up to 68 feet of soft grey-to-black organic silt containing wood, roots, and shell fragments. This unit is also included in the estuarine and salt marsh deposits (Stanford, 1993). The soft organic silt is typically present only within 100 feet of the shoreline throughout the entire study area and represents former river sediments that were buried during shoreline filling. It pinches out to the west near MW-7 and against the bedrock high to the northwest between MW-C and MW-O on the former Celotex property.
- **Shallow native sand.** Up to 21.5 feet of fine to medium/coarse sand with varying amounts of gravel and fines. In the central portions of the Quanta property and the northern portion of the former Lever Brothers property where the peat/clayey peat and soft organic silt are absent, the shallow native sand resides directly beneath the fill unit. This unit’s characteristics in the shoreline area are discussed further in Section 3.1.2.
- **Silty clay (confining unit).** Up to 35 feet of continuous silty clay with varying amounts of fine sand. The silty clay represents a lake-bottom unit that underlies the estuarine and

salt marsh deposits (Stanford, 1993). The silty clay serves as a confining unit and an aquitard between both the overlying native sand and fill units and the underlying deep sand deposits. It is found across most of the site with an undulating surface that dips eastward in close proximity to the existing shoreline and pinches out towards the north against a bedrock high at the former Celotex property. A surface contour figure illustrating the elevation of the top of the silty clay surface is included as Figure 3-9.

- **Deep sand.** Up to approximately 32 feet of fine to coarse sand, sand with varying amounts of silt and clay, and silt and clay with varying amounts of sand. The deep sand represents a lacustrine fan unit that lies beneath the confining silty clay unit (Stanford, 1993). Like the overlying silty clay confining unit, the deep sand dips eastward under the Hudson River and pinches out towards the north against the bedrock high present on the former Celotex property and to the west against the rising Palisades ridge.
- **Till.** Up to 12 feet of a very dense, low permeability, reddish-brown to reddish-yellow silty sand and sand with gravel, cobbles, and boulders. Borings at MW-135, PZ-6, PZ-7, BH-1, and BH-2 confirmed the presence of the till unit during the SRI. Confirmation of the stratigraphy in this area revealed that MW-116DS was in fact screened within the till unit and not within the deep sand, as had been previously thought. Cross section B-B' in Figure 3-2 displays the till unit in relation to MW-116DS. A reassessment of historical soil boring logs from locations throughout the Site, showed that till was present at other locations across the Site, including MW-101DS, MW-103DS, MW-107DS, GZA-90, SS-24C, and SS-25A. During the SRI it was also observed at MW-127, located on the western edge of Block 93 Central and at MW-128 and MW-129 at Block 94 close to the Palisades ridge.
- **Bedrock.** As noted in the RI Report (Appendix A), the Stockton Formation composes the underlying bedrock formation at the Site and is found at depths ranging from 8.5 to 86 feet bgs. Its appearance in core samples collected during the SRI from locations MW-135, BH-1, BH-2, PZ-6, PZ-7, and PZ-8 consisted of variably consolidated alternating sandstone and siltstone lenses with a variety of colors, including, red, white, pink, brown-gray, and brown-yellow. Observed bedrock samples are consistent with the description of the Stockton Formation from Drake et al. (1996). A bedrock high is present in the south-central portion of the former Celotex property, with bedrock present as shallow as 8.5 feet bgs at SB-T15 and generally no more than 10 to 12 feet bgs (SB-T18, SB-U18, SB-U21, MW-D, and TL 17-03). Towards the east and southeast bedrock dips dramatically forming the Hudson River channel. An updated sitewide bedrock surface contour map is included as Figure 3-10.

3.1.2 Shoreline Stratigraphy

During SRI activities, seven boreholes (MW-134, MW-135, BH-1, BH-2, PZ-6, PZ-7, and PZ-8) were advanced using rotosonic drilling methods on the Quanta Resources and the former Celotex properties to depths ranging from 26 to 75 feet bgs. These locations, with the exception of MW-134, were drilled several feet into the top of the bedrock. In addition to those locations completed during the SRI, historic soil boring logs from 11 geotechnical locations (Appendix Y) completed along the shoreline in the northern portion of the former Lever Brothers property were obtained from GZA GeoEnvironmental, Inc., at the request of CH2M HILL to determine the deeper stratigraphy below the meadow mat and organic silts

in this area. Geologic cross sections for the shoreline area are provided as Figures 3-11 (cross section B-B') and 3-12 (cross sections K-K', L-L', M-M', and N-N'), and a plan view representation of transect lines is provided as Figure 3-13. Figures 3-1, 3-2, 3-6, and 3-7 provide site wide geologic cross sections A-A', B-B', F-F', and G-G' and also include the shoreline area in their depictions.

In general, the SRI has shown that bedrock near the current shoreline is deeper than had been thought and that it slopes downward from 24 feet bgs (PZ-6) at the northeast corner of the Quanta property to 67 feet bgs at PZ-8, just 200 feet to the south. Review of the historic geotechnical boring logs (Appendix Y) from the former Lever Brothers property also indicates that the downward sloping bedrock surface continues farther south of the Quanta property, where it was observed at 86 feet bgs at location 1948-2.

Along the shoreline, a thin layer of till ranging from 0.5 to 12 feet overlies the bedrock. To the south the till is overlain by thin layers of deep sand followed by the silty-clay aquitard. These deposits pinch out to the north along the shoreline as the bedrock surface rises. Here the till is overlain by either a thin layer of native sands or soft organic silts. Above the organic silt is fill material generally about 15 feet thick but can be as much as 35 feet thick at the former Celotex property where significant additional filling occurred during shoreline redevelopment in 2003. Section B-B' in Figure 3-2 shows a cross-sectional view of the shoreline stratigraphy from south to north.

3.2 Wooden Bulkhead

A detailed visual inspection and a geophysical investigation were performed along the shoreline to evaluate the current condition and dimensions of the wooden bulkhead present along the shoreline of the Quanta and 115 River Road properties and to determine if any other former bulkhead structures may be present farther inland. The resulting data were designed to aid in understanding groundwater flow and shoreline NAPL distribution and mobility as specified in SRI Objectives 3, 4, and 8. Details on the methodologies used during the two-phase geophysical investigation performed by Hager-Richter are provided in their report, included as Appendix W.

3.2.1 Visual Inspections

Through visual inspection of the bulkhead at the ground surface at OU1 and from the east and because of conversations with the property owner for 115 River Road, the bulkhead appears to extend from the northeast corner of the Quanta property to the southern edge of the 115 River Road building. The lateral extent of the bulkhead and its general configuration is shown in plan view in Figure 3-13. In general, the bulkhead is composed of 2-inch-thick by 6-inch-wide wooden boards held in place by thick wooden cross-beams resting on driven vertical wooden piles and supported laterally by angled wooden piles.

Where visible at the ground surface at OU1 and from the east, the individual boards that make up most of the wooden bulkhead are weathered and deteriorating at the ground surface but are competent between the mean water level of the Hudson River and the sediment surface. The presence of smaller sections of sheet pile between larger sections of newer wooden bulkhead boards beneath the portion of the 115 River Road parking lot supported by pilings suggests that the bulkhead has been maintained and modified along

the shoreline at this active property. The extent of the bulkhead to the south beneath the 115 River Road building where visual observations were not possible has been estimated based on conversations with the current property owner, who indicated that the bulkhead extends under the building at the shoreline. Farther south along the shoreline of the former Lever Brothers property, the bulkhead was not observed and erosion of the shoreline soils is evident. Photographs 1 through 15 of Appendix Z document the bulkhead's construction and condition and show where the bulkhead is present and absent along the shoreline.

Although much of the bulkhead is inaccessible for visual inspection from beneath the concrete overhang, a separation of bulkhead boards was observed just above the sediment surface, adjacent to the PZ-7 piezometer cluster (Photo 8 in Appendix Z). Here, and at other locations beneath the concrete overhang, groundwater leakage through the bulkhead has been observed when tidal conditions are such that the boards are exposed. When the sediment surface is exposed during low tide, erosional features can be seen in the form of rivulets on the sediment surface, originating from these breaches. To the south of the concrete overhang near the former pier structure, the wooden bulkhead angles to the east and is exposed on both the western and eastern sides as the result of the collapse of portions of an elevated concrete platform that once existed between MW-105 and bulkhead. This has resulted in greater decomposition of the bulkhead boards at the surface in this area. The breakdown of the boards adjacent to MW-105 has resulted in the overlapping of river water during high-tide.

3.2.2 Geophysical Surveys

The first phase of the geophysical survey was conducted using surface geophysical methods (Section 2.1.14) in specific areas of interest along the shoreline of the Site, as shown in Figure 2-6. The purpose of the geophysical survey was to identify subsurface structures (e.g., former bulkheads) within 300 feet of the current shoreline. Figure 3-12 from Hager-Richter's Phase 1 Report (Appendix W) presents a plan view interpretation of the results of this phase of the geophysical survey work. Though no evidence of inboard bulkheads was detected using the methods described, numerous anomalies were detected, including expansive areas of concrete (both reinforced and not) and two unidentified large wooden structures that may be former piers or docks. Nonmetallic structures were detected which might be remnants of foundation elements or buried pads from former operations. Remains of a possible buried pier were found in the southeast corner of the Quanta property. This elevated structure is partially collapsed and is located just to the west of the most decrepit portions of the bulkhead to the south of the overhanging concrete pier. Various possible utility lines and localized areas of buried metallic objects were also detected through the survey area. A possible buried vault about 150 feet west of PZ-7 was also detected during this phase of work.

The second phase of the geophysical survey was completed at two areas adjacent to the wooden bulkhead along the shoreline at the Quanta property adjacent to the concrete overhang. Parallel seismic methods, as described in Section 2.1.14, were used to determine the depth of bulkhead boards as well as vertical and angled wooden piles using the cased boreholes installed at BH-1 and BH-2 (Figure 2-6). The depth of the bottoms of the bulkhead boards and wooden piles were determined for each of these locations as follows:

Object	Location (Feet)	
	BH-1	BH-2
Bulkhead	28	30.5
Vertical pile	28	38.5
Battered pile	28	39.3

Figure 3-14 depicts a general layout and geometry of the parallel seismic method with a schematic of the bulkhead, piles, and concrete pier, relative to Hudson River and the Quanta property. Additionally, although the bulkhead appears to show evidence of weathering and rotting above the Hudson River level, the apparent faster seismic wave velocities that were recorded for the bulkhead material below the mean water surface suggest that it has not significantly deteriorated and is competent.

3.3 Hydrogeology

A detailed discussion of groundwater flow direction, hydraulic conductivity, groundwater flow velocities, and tidal effects for the water-bearing zones at the Site were presented in Section 3.3 of the RI Report (Appendix A). The discussions in the RI Report remain relevant and represent the most comprehensive description of the hydrogeologic characteristics for OU1. Hydraulic head measurements were collected at new and existing monitoring wells as part of the SRI to refine the understanding of groundwater flow paths across the Site. Hydraulic data provide new information about the area to the west of Block 93 and within nearshore areas of OU2 to better understand the distribution and fate and transport of organic and inorganic constituents in groundwater at and downgradient of the Site. The data needs specified in the SRI Work Plan included the following:

- Hydraulic head information for unconfined groundwater across and upgradient (west) of Blocks 93 North, Central, and South to evaluate the direction of groundwater flow in these portions of the Site (SRI Objective 1)
- Hydraulic head information along the shoreline adjacent to and north and south of the wooden bulkhead and at varying depths within OU1 and OU2 to determine groundwater flow paths from OU1 to OU2 (Objective 8)
- Identification of groundwater-upwelling zones at OU2 downgradient of observed impacts in groundwater at OU1 (Objective 8)

3.3.1 Refinements of Sitewide Hydrogeology

Sitewide synoptic water level events were conducted during midtide conditions in November 2008 (Table 2-7) and March 2009 (Table 3-1), prior to the initiation of groundwater-sampling activities. Depth-to-groundwater measurements were recorded in available monitoring wells screened within the shallow unconfined aquifer (above the silty clay unit) and the confined deep sand unit (below the silty clay unit). Groundwater potentiometric surface figures for both hydrostratigraphic units were prepared using the March 2009 synoptic event data and are included as Figures 3-15 and 3-16.

In general, the shallow unconfined groundwater flow paths depicted in Figure 3-16 are consistent with the depiction in Figure 3-5 of the RI Report. The direction of the shallow groundwater is predominately to the east and southeast toward the Hudson River which confirms the description in the RI Report. The installation of additional data points during the SRI has resulted in a more comprehensive understanding of groundwater flow in this area. The additional data have revealed that an area of slight mounding exists near the intersection of Gorge and River Roads and the western portions of the Quanta property, where the low-lying unpaved ground surface on the Quanta property has resulted in greater localized recharge and the presence of peat (Figures 3-4 and 3-7) may be resulting in the perching of groundwater. As such, shallow groundwater flows radially outward from this area. However, groundwater gradients between wells screened across the water table appear to be an order of magnitude lower across the central part of the Site (approximately 0.004 ft/ft), suggesting, according to Darcy's law, that flow velocities are also reduced by the same factor and are on the order of 10^{-4} cm/sec, approximately 0.05 ft/day. To the west, where groundwater flow patterns were not previously defined, groundwater flows from the foot of the Palisades to the east and south with a greater southerly component to the south on Block 93 Central and South. The additional data have also revealed that groundwater near the high-concentration arsenic area (HCAA) does not flow westward toward Block 93 North and Block 94, and that groundwater on Block 93 flows south before angling eastward toward the Hudson River near the former Lever Brother's property. The confirmation of the absence of westerly groundwater flow from the HCAA has addressed a key data gap associated with SRI Objective 7 and demonstrates that elevated arsenic concentrations in groundwater at Block 93 North are not the result of advective transport in groundwater from the HCAA but are instead the result of a localized source of arsenic. This is discussed in detail in Section 5.3.2.

Consistent with all previous synoptic water level-gauging events and depicted in Figure 3-5 of the RI Report is a groundwater convergence zone in the central to eastern portions of the former Lever Brothers property. Within this convergence zone, shallow unconfined groundwater from the central portions of the former Lever Brothers flows to the northeast and converges with groundwater from the Quanta property. This area of convergence coincides with a pair of west-to-east-trending storm drain lines that outfall to the Hudson River near the area where the convergence feature typically is observed. The drain lines and/or artificially emplaced material surrounding it, if present, could be influencing groundwater flow in a localized area.

The potentiometric surface of groundwater within the deep sand hydrostratigraphic unit was based on data collected from those wells screened within the deep sand unit and is shown in Figure 3-15. Based on the refinements to the definition of stratigraphy along the shoreline areas, monitoring well MW-116DS was not used during the deep sand potentiometric surface mapping because it is now known that this well is screened in the soft organic silt and till above the bedrock surface where deep sand is not present. Exclusion of this well and the inclusion of the newly installed PZ-8D have resulted in a depiction of deep sand groundwater indicating that flow has less of a southerly component than that depicted in Figure 3-6 of the RI Report (Appendix A). Groundwater in the deep sand unit flows more uniformly than the overlying unconfined groundwater and moves in an east-southeasterly direction, towards the Hudson River.

3.3.2 Shoreline Area

A greater understanding of groundwater flow paths and discharge to the Hudson River at the shoreline and near the bulkhead has been achieved through the installation of piezometer clusters along the shoreline area, within nearshore areas at both OU1 and OU2, and the completion of six rounds of high- and low-tide synoptic water level events in December 2008, in combination with a Trident sensor survey and surface water and pore water sampling in OU2. Hydrographs for the OU2 piezometer clusters (Figure 2-2) were used to confirm that the hydraulic heads measured in the OU2 piezometers had equilibrated with the adjacent formation and that they were in communication with the interstitial pore water adjacent to their screens. With the exception of PZ-5D, the head measurements taken at each piezometer over the shoreline monitoring conducted between December 5 and 13, 2008, showed that the hydraulic heads were stable and responding to tidal fluctuations as measured at the onsite staff gauge (TGS-1). During this time, piezometer PZ-5D exhibited an increasing trend that suggested recharge at this location was very slow and still occurring. Subsequent follow-up monitoring at the PZ-5 cluster on January 5, 2009, showed a pattern among the piezometers here that was consistent with other locations (increasing hydraulic head with depth) and suggested that equilibration at this piezometer had been achieved. Figures 3-11 and 3-12 show flow net cross section diagrams that were developed using an average of the hydraulic head data for each monitoring point collected during the December 2008 shoreline water level-monitoring events. For PZ-5D, the hydraulic head data collected on January 5, 2009, were used. Equipotential lines were developed using these data to determine the general groundwater flow paths across the interface between OU1 and the Hudson River, including those areas where the wooden bulkhead is present. In addition to flow net cross sections, plan view potentiometric surface contours for shallow groundwater near the shoreline area are also presented in Figure 3-13. These illustrate the lateral movement of groundwater up to and around the bulkhead.

As groundwater contours in Figure 3-13 illustrate, the bulkhead represents a significant impediment to groundwater flow between OU1 and OU2. Due to its relative impermeability, groundwater mounds behind the bulkhead in the nearshore areas and migrates laterally around the bulkhead to the north and south. This is illustrated in the south-to-north-trending flow net section B-B' (Figure 3-11), where strong northerly and southerly components of flow are observed at the lateral extents of the bulkhead; hydraulic heads directly behind the bulkhead are consistently higher than those to the north at the former Celotex property and to the south at the former Lever Brothers property. As detailed in Section 3.3.3 of the RI Report (Appendix A), a tidal study conducted in November 2005 showed that monitoring wells screened in the shallow aquifer along the shoreline of the Quanta property (MW-116A, MW-117A, MW-117B,) did not display evidence of a strong tidal influence when compared to other monitoring wells south of the Quanta property (MW-119A, MW-120A, MW-109A). This condition is supported by the results of the Trident probe survey and surface water and pore water sampling, which reveal that the most significant area of groundwater discharge is south of the bulkhead, extending out into OU2 near the pier connected to 115 River Road. Specifically, an area of groundwater upwelling (lower bulk temperature and conductance in the subsurface compared to that of the surface water) was identified at Trident Probe location TP-2A (GWZ-5), which displayed the lowest conductivity measurements recorded during the survey.

Although the bulkhead impedes groundwater flow from OU1 to the Hudson River, there is also evidence that there are areas along the bulkhead where groundwater leaks through this structure. In addition to the observations of leakage discussed previously, in Section 3.2.1, hydraulic head data collected during the synoptic events in November 2008 and March 2009 and during the shoreline monitoring performed in December 2008 indicate two wells (MW-105A and PZ-7) directly behind the bulkhead whose hydraulic heads are consistently lower than those at adjacent wells. These lower heads suggest that localized areas of groundwater convergence exist adjacent to the bulkhead where groundwater may be leaking across the wooden structure. An area of groundwater upwelling (lower bulk temperature and conductance in the subsurface compared to that of the surface water) was identified at Trident Probe location TP-7A (GWZ-1) (Figure 2-5). This is also consistent with the observations at piezometer cluster PZ-7. Lower subsurface water conductivities were also observed immediately downgradient of monitoring well MW-105A at Trident probe location TP-4A. The identification of groundwater upwelling zones and the groundwater surface water interaction is discussed in more detail in the following section.

Water level data collected from most newly installed OU1 and OU2 piezometer clusters during the shoreline monitoring events conducted in December 2008 suggest that a strong upward vertical flow component exists from the underlying bedrock and deep sand confined unit. This upward flow has consistently been observed at well and piezometers clusters to the west (OU1 shoreline) and east (nearshore areas of the Hudson River) of the wooden bulkhead. As illustrated in the flow net cross sections presented in Figures 3-11 and 3-12, hydraulic head measurements collected at each piezometer cluster show decreasing hydraulic heads from deep to intermediate and shallow screens. Beyond the bulkhead these strong gradients are driving groundwater upward towards the surface water interface in the nearshore area.

Farther from shore at the PZ-5 piezometer cluster, upward gradients are less significant. As illustrated in flow net section K-K', this condition is also observed in the area north of the bulkhead. To the south, adjacent to the former Lever Brothers property (flow net section N-N'), strong upward forces were not observed at piezometer cluster PZ-4, suggesting that discharge to surface water may be occurring farther from the shoreline in the area near this location. This difference is consistent with the results of the groundwater upwelling study (discussed in the following section), which identified that the most significant areas of groundwater discharge are 60 feet farther east of the shoreline than PZ-4 at GWZ-5 and beyond.

3.3.3 Groundwater Upwelling

A groundwater-upwelling survey was performed using the Trident probe downgradient of locations at which dissolved phase constituents were observed in OU1 groundwater. The purpose of the survey was to identify areas of preferential groundwater discharge. This information was used to identify areas of discharge and, later, sampling locations at which pore water and surface water quality would be measured. Details on the methods and procedures used to perform this work are provided in Section 2.1.13.

During the Trident probe survey, temperature and conductivity measurements were collected from subsurface and surface water at 55 locations in OU2. Relative differences in the conductivity and temperature measurements within the subsurface (approximately 18

inches below the sediment surface) and the surface water (approximately 12 inches above the sediment surface) at each location were used to qualitatively identify areas of potential upwelling. During summer, groundwater in this region is expected to be cooler and have a lower conductivity than the surface water. Subsurface water's not being cooler and not having a lower conductivity than the surface water would indicate that groundwater upwelling may not be occurring. The variations between subsurface conductivity and surface water conductivity were the most useful indicator of upwelling in OU2.

Temperatures were more uniform and exhibited smaller variations across the study area; therefore temperature was used as the secondary parameter to identify areas of upwelling. Trident probe survey locations are illustrated in Figure 2-5.

Subsurface water conductivities ranged from 4.33 to 14.83 mS/cm, with a study area average of 9.29 mS/cm. Surface water conductivity values ranged from 18.72 to 26.25 mS/cm, with a study area average of 15.08 mS/cm (Table 2-13). The lowest subsurface water conductivity values were concentrated in the southern portion of the study area from transects 1-4, both in the nearshore and offshore stations. Other zones with relatively low conductivities (e.g., < 8.7 mS/cm) were also identified offshore along transect 5-6 and inshore along transects 10-11. An isolated station with low conductivity was also identified at 7A.

Subsurface temperatures in the offshore region varied by only about 3°C, ranging from 20.45 to 23.74°C, with a study area average temperature of 21.43°C (Table 2-13). Relatively cooler temperatures were observed in the southern portion of the study area along transects 1-2, particularly in the midshore to offshore stations (B through E). Other zones of cooler subsurface temperatures were observed offshore along transects 3-6 and 10-11. Isolated zones of cooler subsurface temperature were also found at stations 3A and 7C. These cooler subsurface temperatures measured in the above mentioned areas are indicative of potential groundwater upwelling.

Conductivity differences provide the best indicator of potential discharge zones because the temperature variations are less pronounced. The correspondence of these low-conductivity zones with cooler temperature also tends to increase the likelihood of potential influence from groundwater discharge. Based on the subsurface conductivity and temperature mapping, potential groundwater discharge zones were identified primarily in the southern portion of the study area along transects 1-2 (Figure 2-5). Nearshore areas with lower subsurface conductivity were also identified as potential groundwater discharge areas of interest due to their proximity to nearshore groundwater where elevated concentrations of dissolved phase constituents were known to exist. Based on the results of the sensor survey, five target pore water-sampling stations were selected: 11A, 7A, 4D, 2D, and 2A. These stations represent the most likely discharge areas on the basis of either low conductivity or corresponding low conductivity and temperature (Table 2-12). Results from the pore water sampling are discussed in Sections 4 and 5.

The results of the groundwater-upwelling study are consistent with hydraulic head data collected at OU1 and at nearshore nested piezometers at OU2 which reflect that most of the groundwater discharge is occurring south of the bulkhead, extending into OU2 near the pier connected to 115 River Road. The identification of areas of groundwater upwelling farther from the shoreline in the southern portion of the study area is consistent with absence of an

upward component of groundwater flow at the PZ-4 nested piezometer cluster along the northern edge of the former Lever Brothers property.

To a lesser degree, groundwater discharge also appears to be occurring north of the bulkhead and in discrete, nearshore areas adjacent to the bulkhead, where hydraulic data suggest leakage through the bulkhead is occurring.

Potential groundwater upwelling zones, depicted in Figure 2-5, do not necessarily represent areas where constituent flux is occurring to the shallow pore water and surface water at OU2. These wider areas of groundwater upwelling have been evaluated using the results of subsequent shallow pore water sampling to determine if and where flux of Site constituents is occurring at OU2. This evaluation is presented in Sections 4 and 5.

SECTION 4

Non-Aqueous Phase Liquid and Coal Tar Constituents

Detailed discussions on the nature, extent, fate, and transport of coal tar and NAPL constituents were presented in Sections 4 and 5 of the RI Report (Appendix A). Based on EPA comments and subsequent meetings and discussions, additional information was required to complete the delineation of NAPL and NAPL-related constituents in soil and groundwater for the development of a set of remedial alternatives for the Site. Data collected as part of the SRI and that have been used to address components of SRI Objectives 1, 2, 3, 4, 6, and 8 are discussed in this section.

These objectives were presented in detail in the approved SRI Work Plan and are summarized below:

- The nature and extent of NAPL and coal tar constituents near Block 93 and the northwest portion of the former Lever Brother's property and in the intersection of Gorge and River Roads (Objective 1)
- The nature and extent of NAPL in the northeastern portion of the former Lever Brother's property (near MW-106A) near a former AST of unknown contents to confirm the type of NAPL previously observed in soils at boring MW-106A and to determine whether it is coal tar (Objective 2)
- A refined understanding of the distribution of NAPL behind and at the ends of the wooden bulkhead (Objective 3)
- The dimensions of the wooden bulkhead and its role in limiting NAPL migration (Objective 4)
- The documented stability of NAPL related constituents in groundwater at OU1 (Objective 6)
- Groundwater flow paths, distribution, and fate and transport of NAPL and coal tar constituents (VOCs and PAHs) across the GW/SW transition zone(s) between OU1 and OU2 (Objective 8)

This section presents the relevant data collected as part of the SRI and updates the discussions of the nature and extent and the fate and transport of Site constituents in both soil and groundwater presented in Sections 4.3, 4.4, 5.4, and 5.5 of the final RI Report (CH2M HILL, 2008a). Comprehensive discussions in the RI Report on the suspected and known sources of contamination, the composition and characteristics of Site-related NAPL, and the fate and transport of these constituents in soil and groundwater remain relevant and applicable unless otherwise noted herein. NAPL zones have been refined and will be used in the development of alternatives as part of the feasibility study.

4.1 Non-Aqueous Phase Liquid

Components of Objectives 1 through 4 of the SRI Work Plan were intended to define the extents of NAPL in specific areas west of River Road as well as to further refine the understanding of previously identified NAPL zones along the shoreline and determine the role of the bulkhead in limiting NAPL migration. The distinction between the NAPL zones and the lateral extent of all NAPL is provided in the RI Report. In summary, the descriptions of NAPL zones are intended to characterize and identify the location of primary accumulations of NAPL and to define the areas in which NAPL has been observed over a contiguous area at thicknesses greater than 6 inches. The zones were developed to serve as a preliminary basis for the remedial alternatives analysis that will be part of the OU1 FS and ongoing discussions with the agencies while also highlighting the discrete nature of various NAPL accumulations. Therefore, NAPL zones do not include vertically thin “stringers” adjacent to NAPL zones. As a result, in some instances, small pockets of NAPL exist outside the defined NAPL zones but are not connected to each other or to the larger contiguous NAPL zones (NZ-1 through NZ-5).

4.1.1 Data Evaluations

During the SRI, specific field methods were employed to further define and document the extent of NAPL within specific areas of the Site, as outlined above. The methods employed include TarGOST® profiling, soil screening, visual observations, and laboratory analysis of confirmatory samples. Each of these lines of evidence were combined and used to define the lateral and vertical extents of residual and free-phase NAPL. Figure 2-1 displays the final locations for all TarGOST® and confirmatory soil boring locations. Table 2-2 summarizes the results of the TarGOST® investigation, with an explanation for each location relative to visual observations and laboratory analytical results.

In summary, the highest TarGOST® response observed during the SRI was 904.1 percent RE at boring TL10.5-09.5 at depth of 0.2 foot bgs. The lowest response, -17.3 percent RE, was found at boring TL12.5-00 at a depth 21.8 feet bgs. The response established during RI activities that correlates to the presence of residual or free phase coal tar presence was 49.1 percent RE (described in Section 4.1.1 of the RI Report, Appendix A). During SRI activities this threshold was generally observed to be accurate, on the basis of visual observations and analytical data collected from 17 of the 28 TarGOST® locations. Exceptions to this are presented in Table 2-2 and were the result of significant changes in the soil matrix (i.e., where background readings for clean organic peat were consistently greater than those of other soil types throughout most of the Site) or rare instances where interferences from other sources were confirmed.

Soil logging also allowed for visual confirmation of soil conditions. All PID readings and visual observations of NAPL were recorded on soil boring logs. Similar to the RI, the presence of NAPL within the soil cores retrieved during drilling was determined by careful inspection by the field geologist that involved the compression and smearing of small portions of each soil sample between the thumb and fore finger or in the palm of the hand while wearing clean nitrile gloves. PID readings and strong coal tar odors were also factored in. Generally, NAPL was observed either as a smear on the sampler’s glove or the sampling

device, or within the pore space of the soil sample. In total, soil cores from as many as 23 borings drilled during the SRI.

Multiple lines of evidence were used to define intervals of soil containing free-phase or residual NAPL throughout and beyond the extents of OU1. This evidence was obtained from the 266 boring locations at which continuous soil sampling was conducted. The lines of evidence include visual observations, laboratory analytical data, and TarGOST® response data; the latter was collected from 121 locations (39 of which were also sampled continuously).

To provide a visual representation of this data, the three-dimensional dataset was modeled using kriging and Rockware's RockWorks14 software and an upper boundary that was equal to the ground surface. Intervals of "clean" soil were assigned a value of 0, and intervals of soil containing NAPL were assigned a value of 10. The resulting interval data set was plotted on a grid 20 feet by 20 feet by 0.5 foot thick. The three-dimensional model that was generated resulted in the refinement of each of the NAPL zones depicted in plan view in Figure 3-8. In general, the depictions of NAPL in the cross-sections presented in Figures 3-11 and 3-12 and Figures 3-1 through 3-7 represent slices of the three-dimensional NAPL model. These cross-sections also show the intervals of NAPL based on all lines of evidence (those assigned a value of 10) that were used to develop the NAPL model.

4.1.2 Extent of Non-Aqueous Phase Liquid

Multiple lines of evidence, obtained by combining TarGOST® results with confirmatory borings and historical visual observations (not only from this SRI, but also from investigations of the adjacent properties), were used to refine the delineation of the lateral extent of NAPL at OU1. The SRI has been successful in addressing the data gaps identified in the SRI Work Plan and the delineation of all Site-related NAPL is complete. The updated lateral extents of NAPL as well as revised depictions of the lateral extent of NAPL zones are provided in Figure 3-8. Figures 3-1 through 3-7 show the extent of NAPL across the Site in cross-sectional view.

The revised depictions of free-phase and residual NAPL remain consistent with the locations of former tanks depicted in historical maps (Figure 3-8). As is consistent with the findings in the RI, NAPL is not present as a single, contiguous mass. It is also noteworthy that additional data have been collected that provide further evidence to support the conclusion that, in many areas of the Site, NAPL is being naturally contained by the presence of units of low-permeability material such as organic silt, silty clay, and peat. The deepest extents of NAPL are limited to the soil within and above the silty clay confining unit, where that unit is present. NAPL has accumulated in natural depressions on the surface of the silty clay confining unit or the surface of the shallower peat deposits to the west, except in those areas where it remains above the water table due to elevated viscosities and interfacial tensions that are preventing further downward migration.

In general, the lateral extent of NAPL in the central and eastern portions of the Site is similar to that which was depicted in Figure 4-4 of the RI Report; however, several areas have been refined. The northern extent of NAPL along the shoreline has been revised based on the review of numerous historical borings on the former Celotex property. In addition, to the south along the shoreline the extent of NAPL has been revised to reflect the presence of thin lenses of Site-related NAPL that were identified during TarGOST® and soil boring work

performed in this area as part of the SRI. These findings are discussed in further detail in Section 4.1.3.

Additional data collected as part of the SRI within and west of River Road also show that NAPL extends from the Quanta property to the northwest within the intersection of Gorge and River Roads and up to the southeast corner of Block 92.01. The southerly and westerly extents of thin lenses of NAPL observed at the base of the fill within the interior of Block 93 North at SB-27 and SB-30 have also been defined by its absence at locations TL14-13.25, TL13.5-12.75, TL14-12.25, and TL14.5-11.75. Figure 3-1 shows in cross-section view the absence of NAPL south of SB-30. Numerous borings completed with the southeastern portions of Block 93 North have shown that this NAPL is not contiguous with the larger mass of NAPL observed along the eastern portions of this property.

Farther south, the western extents of NAPL have been defined in the area of Block 93 North, South, and Central, where data gaps remained at the completion of the RI Report. Here a rise in the elevation of the peat deposits within approximately 100 feet of the western edge of River Road acts as a barrier to further lateral migration of NAPL to the west (Figure 3-1). Along River Road to the south, the vertical and lateral extents of NAPL are also bound by the presence of the native peat deposits (Figure 3-5), which dominate the stratigraphy beneath the fill throughout the western portion of the Site and rise in elevation to the south, where they are preventing movement beyond the southeastern corner of the Medical Arts Building adjacent to River Road at Block 93 South.

4.1.3 Refinement of NAPL Zones

As part of the RI Report, most NAPL at the Site was identified to be part of one of five discrete NAPL zones (NZ-1 through NZ-5, as depicted in Figure 4-4 of the RI Report), each of which has been refined using the data collected as part of the SRI and the NAPL visualization tools described in Section 4.1.1. Based on the SRI, a sixth NAPL zone (NZ-6) has been identified. The lateral extents of each of the six NAPL zones are illustrated in Figure 3-8. As shown in Figure 3-8, the location and extent of the NAPL zones are consistent with release mechanisms (tank, piping, or operations), varying physical properties (density and viscosity) of the NAPL, the surface of the silty-clay confining unit, and hydraulic conditions. With the exception of NZ-6, detailed discussions on the chemical and physical properties and the nature and extent of each of the NAPL zones were presented in Section 4.1 of the RI Report. Unless otherwise noted, the following sections are intended to supplement those discussions relative to the specific data gaps defined in the SRI Work Plan.

NAPL zones and areas that were the focus of the approved SRI Work Plan include the following:

- NZ-1, NZ-4, and NZ-6 near Block 93, Block 94, the intersection of Gorge and River Roads, and the northwestern portion of the former Lever Brothers property
- NZ-2 in the northeastern portion of the former Lever Brothers property
- NZ-2 and NZ-5 near the wooden bulkhead

When available, additional detail on the nature and extent and mobility of the NAPL zones has also been included.

NZ-1

The delineation of NZ-1 has been completed. Because of the additional data gathered during the SRI, NZ-1 appears to extend farther westward than was depicted in the RI. Along the western edge of the River Road, NAPL has been detected along the eastern edge of the Blocks 93 North and Central properties at depths ranging from 1 to 20 feet bgs with most NAPL found between 1 and 12 feet bgs. Limited subsurface data are available immediately east within portions of River Road. However, based on the presence of NAPL at similar elevations east at the Quanta and 115 River Road properties, NZ-1 was extended beneath River Road. Most of the NAPL ranges from 6.5 to 20 feet bgs beneath River Road, mainly at 6.5 to 14.5 feet bgs. The presence of NAPL within this portion of the roadway is consistent with reported occurrences of “coal tar” in select borings drilled in June 2000 during a geotechnical investigation aimed at evaluating settlement along River Road (PMK, 2000).

NZ-1 is shown in cross-section view in Figures 3-1 and 3-5. Downward migration of NZ-1 to the west of the Quanta property appears to be limited by the presence of the less permeable meadow mat, or peat unit. As a result, its presence is limited to the fill layer near the water table. This is consistent with PMK’s borings within River Road, which describe occurrences near the water table, which was encountered at approximately 8 feet bgs during drilling (PMK, 2000). As described in Section 4.1.1 of the RI Report (Appendix A), the analytical results of NAPL samples collected from within NZ-1 from wells MW-102A and MW-112B indicated relatively higher viscosities and interfacial tensions compared to other analytical results in other NAPL zones (Table 2-11). The SRI has provided additional evidence to support the conclusion that the NAPL zone is confined vertically. The proximity of the NAPL relative to the water table, the presence of the impermeable peat layer, and the physical characteristics of this NAPL suggest that further migration is unlikely. In areas where NZ-1 has migrated to the surface of the peat unit near Block 93 (e.g., at TL14-10.75 and SB-22) penetration of the peat has not occurred. The peat and silty clay units display a shallower upper contact towards the north, south, and west of NZ-1’s footprint on Block 93 providing a depression that would contain NZ-1 NAPL if it were to migrate deeper (Figures 3-1 and 3-5).

The one area within NZ-1 where deeper occurrence of NAPL have been observed in fill present to depths of up to 23.5 feet bgs is near the MW-102 series wells in the western corner of the Quanta property (Figure 3-4). As Figure 3-8 shows, this location corresponds with the location of a former coal tar underground storage tank (UST) and greater thickness of fill. The presence of NAPL here is the result of disturbances to the subsurface and the reworking of soils caused by the placement or removal of this former UST.

NZ-2

The delineation of NZ-2 has been completed. Objectives, 2, 3, and 4 of the SRI Work Plan focused on refining the nature and extent of NAPL along the shoreline area and determining the dimensions of the wooden bulkhead and its role in limiting NAPL migration to OU2. As previously identified in the RI Report, most NAPL along the shoreline at OU1 is located at NZ-2, which extends from the northern Quanta property boundary southward, beneath the 115 River Road building, and onto portions of the northeast corner of the former Lever Brothers property. The bulkhead is present along the Quanta property but not south of the 115 River Road building. An objective of the SRI was to refine the

vertical extents of NAPL relative to the bulkhead and determine the vertical and lateral extents of the NAPL to the south at the former Lever Brothers property where additional non-Site-related sources had been observed during the RI. The SRI was successful in addressing these data gaps. Resulting depictions of the lateral and vertical extents of NZ-2 are provided in plan view in Figure 3-8 and in various cross-sectional views provided in Figures 4-1, 3-1, 3-2, 3-12, and 4-1.

NAPL at NZ-2 is present along the shoreline of the Quanta and 115 River Road properties between 4 and 25 feet bgs, and extends approximately 250 feet inland westward, where it is present at significantly shallower depths (generally between 0.5 and 12 feet bgs). A detailed discussion of NAPL at NZ-2 relative to the bulkhead structure is provided below in the subsection "Shoreline Area in the Vicinity of the Wooden Bulkhead." To the south, NAPL at NZ-2 extends within approximately 100 feet of 115 River Road as thinner stringers generally less than 1 foot thick at a depth of approximately 23 feet bgs that extend only 130 feet west of the shoreline. Additional details on the refinements to the southern portion of NZ-2 are discussed in the "Northeast Corner of Former Lever Brothers Property" subsection, below. The northern boundary of the Quanta property marks the northern extent of NZ-2. Similar to the flanks of the bulkhead to the south, additional borings completed to the north of NZ-2 at NZ-5 (MW-134 and MW-135) show deeper and thinner deposits of NAPL and have confirmed that NAPL is contiguous between these two zones. Further discussion on the NAPL present at NZ-5 is provided below.

Shoreline Area near the Wooden Bulkhead. The vertical extent of NZ-2 was refined through the completion of five roto sonic soil borings with continuous soil sampling along the shoreline at the Quanta property (PZ-6, PZ-7, PZ-8, BH-1, and BH-2). The vertical and lateral extents of NAPL associated with NZ-2 are depicted in cross-sectional view in Figure 3-2.

The thickest intervals of NZ-2 NAPL are located upgradient and immediately west of, the bulkhead where they are found between 4 and 25 feet bgs extending through the fill unit and into the upper portions of the organic silt deposits with sporadic occurrences within the underlying till to the north where these deposits are found at shallower depths. An enhanced understanding of the NAPL distribution behind the bulkhead at OU1, in conjunction with sediment boring information for OU2, show that NAPL in nearshore sediments is at a similar elevation to that of the NAPL behind and at the end of the bulkhead (NZ-2 and NZ-5) (GeoSyntec, 2000; CH2M HILL, 2007d). The distribution of observed NAPL suggests that the highest levels of NAPL saturation behind the bulkhead are at the interface between the base of the fill and the top of the organic silt. The detection of NAPL at PZ-7 as deep as 23 feet bgs is consistent with historical observations within the boring for MW-116DS which showed NAPL as deep as 25 feet bgs. However, as described in Section 3.1.1 these deeper occurrences of NAPL do not reside within the deep sand unit, but instead are within the organic silt and adjacent till deposits to the north (Figure 3-2). Borings drilled to bedrock at PZ-6, PZ-7, BH-1, and BH-2 confirmed that the deep sand is not present along the shoreline at most of the Quanta property as it pinches out just to the north of PZ-8 against the rising bedrock surface.

As described in Section 3.2.2, the results of the down-hole geophysical work performed at borings BH-1 and BH-2 confirmed that the depth of the wooden bulkhead at the Quanta property extends to depths ranging from 28 to 30.5 ft bgs. These results support the conclusion that NAPL at NZ-2 does not extend beneath the base of the wooden bulkhead.

Cross-section A-A' in Figure 3-1 and cross-sections L-L' and M-M' in Figure 3-12 illustrate the vertical extent of NAPL at NZ-2 relative to the wooden bulkhead structure and Site stratigraphy.

NAPL impounded behind the bulkhead appears to have seeped laterally to both the north and south beyond the extents of the bulkhead. At the edges, only thin lenses of NAPL are found at the top of the organic silt beneath intervals of fill where NAPL is not present. NAPL at NZ-2 has viscosities ranging from 27.44 cSt at MW-116B to 181.6 cSt at MW-105 (measured at 122°F) with interfacial tensions of 18.0 and 30.2 dynes/cm, respectively. The sample results from these two locations indicate that NZ-2 is not homogeneous and has a range of physical characteristics both of which impede migration. Most recently, during the SRI, a measureable thickness of NAPL was observed to be floating on the water column at monitoring well MW-105A. Although thin layers of LNAPL had been observed previously at several wells at the Site, this represented the first time that a sufficient thickness to allow for sampling had been observed. Analytical results showed that the product consisted of a combination of coal tar and an unknown hydrocarbon. Viscosity of the LNAPL at MW-105A was measured at 105 cSt at 50°F, which using the three-point temperature measurements conducted for viscosity, was determined to be equivalent to 17.3 cSt at 122°F (for comparison with NAPL samples collected during the RI). Its interfacial tension was unable to be determined because the sample was a mixture of different types of NAPL.

Northeast Corner of Former Lever Brothers Property. During drilling for the installation of MW-106A, NAPL was observed between 9.5 and 14 feet bgs adjacent to the remnants of the concrete tank pad associated with historical operations at the former Lever Brothers property. Laboratory analytical results for a soil sample collected during the RI at this location showed the presence of elevated levels of benzene, toluene, ethyl benzene, and xylene (BTEX) compounds in the absence of PAHs. This signature is not consistent with Site-related NAPL and soil impacts. Additional field work was performed in this area as part of the SRI to determine whether the NAPL observed in this area was coal tar or some other type of NAPL that may have been a result of releases associated with operations at the former Lever Brothers property.

TarGOST® and conventional soil borings with continuous soil sampling and laboratory analytical were completed south, east, and north of MW-106A. To the south and east, TarGOST® borings TL11.75-00, TL11.25-00, and TL11-00 showed thin intervals of elevated TarGOST® responses between 14 and 17.5 feet bgs. Subsequent soil sampling involving fingerprinting, VOC, and SVOC analyses at TL11.25-00 (16.5 to 18.5 feet bgs) and TL11.75-00 (13 to 14 feet bgs) showed that these responses were not related to the presence of coal tar (Appendices AA, E, and G). Low concentrations of PAHs and high concentrations of BTEX were reported in both samples. Fingerprinting results indicated the presence of primarily non-coal tar weathered petroleum hydrocarbons. The elevated TarGOST® responses within these intervals are a result of the presence of petroleum hydrocarbons that may act as solvents, resulting in the dissolution of PAH compounds in the fill material causing elevated TarGOST® responses.

To the north and west of MW-106A and downgradient of a known release associated with historical soap-manufacturing operations at the former Lever Brothers property (Section 4.1.1 of the RI Report), an elevated TarGOST® response was also observed at TL12-01.5 between 6 and 11 feet bgs. A soil sample collected from this interval (7.1 to 10 feet bgs)

indicated low levels of BTEX and PAH compounds that were inconsistent with Site-related NAPLs. TPH fingerprinting results from this sample indicated the presence of weathered fuel oil that is unrelated to OU1. An additional interval of NAPL observed at this location between 12 and 15 feet bgs exhibited an elevated TarGOST® response different than that above and was found to consist primarily of an unresolved petroleum hydrocarbon. The anomalous NAPLs at this location are unrelated to OU1. The elevated TarGOST® responses at TL12-01.5 are likely the result of the presence of a petroleum hydrocarbons that may be acting as a solvent to the PAH compounds in the fill material allowing them to more readily fluoresce when exposed to the TarGOST® laser.

TarGOST® results and confirmatory borings with visual observations and analytical sampling at SRI locations TL12-00.5, TL12.5-00 showed the presence of background hydrocarbons (TL-12-00.5, 7 to 8 feet bgs, and TL12.5-00, 17 to 18 ft. bgs) and possible thin lenses of coal tar associated with NZ-2 with other petroleum hydrocarbons (TL-12-00.5, 17 to 19.5 feet bgs) between 14.5 and 25 feet bgs just to the north of MW-106A near the former tank pad. The completion of seven additional borings in this area and the confirmation of the presence of additional non-Site-related sources have resulted in the delineation of NZ-2 to the south. Delineations of non-Site-related NAPLs relative to NZ-2 are shown in plan view in Figure 3-8 as well as in cross-sections Q-Q', R-R', and S-S' in Figure 4-1. Soil conditions related to the NAPL observed at MW-7 are outlined in orange, and those related to other sources of non-coal tar weathered petroleum hydrocarbons believed to be associated with the former AST are outlined in green.

NZ-3

The delineation of NZ-3 has been completed. Extending from the central portion of the Quanta property south into the former Lever Brothers property beyond the lateral extent of NZ-1, this NAPL zone extends from approximately 15 feet bgs to a few feet into the top of the silty-clay confining unit at approximately 22 to 25 feet bgs. The lower interfacial tension (8.2 dynes/cm²) and viscosity (3.49 cSt) of the NAPL sample collected at MW-107 suggest that this NAPL was able to overcome the pore pressures associated with the shallow fill and native sand units. This condition allowed the NAPL to migrate downward and laterally until reaching a natural depression in the top of the undulating surface of the silty-clay confining layer, which limits further migration (Figure 3-9).

Although additional delineation of NZ-3 was not performed during the SRI, refinements to the understanding of stratigraphy, and specifically the surface of the silty-clay surface, have resulted in updated depictions of this NAPL zone. NZ-3 is shown in cross-sections A-A', C-C', and F-F' in Figures 3-1, 3-3, and 3-6, respectively. Throughout most of NZ-3, the silty-confining layer unit up slopes to create the natural depression that prevents further lateral migration of the NAPL. Along the southeastern portion of NZ-3 the silty-clay layer dips downward below the organic silts and is overlain by native sand (Figure 3-6). Along the edge of NZ-3 in this direction NAPL is present only as thin and discontinuous lenses indicating that under current conditions, the NAPL at NZ-3 is not migrating beyond the natural depression in the top of the silty-clay confining unit.

NZ-4

As part of the SRI activities, the delineation of NAPL associated with NZ-4 has been completed. NZ-4 extends from the northwestern portion of the former Lever Brothers property and across River Road onto Blocks 93 Central and South (Figure 3-8). Cross-section E-E' in Figure 3-5 illustrates the vertical extent of NAPL associated with NZ-4 from the southwest towards the northeast. It comprises two separate lenses, the first between approximately 10 and 15 feet bgs, and the second between approximately 20 and 32 feet bgs. The first lens occurs mostly in the fill layer or into the first few feet of the peat unit. The second lens penetrates the peat, near MW-123 but is sporadic and not discontinuous.

Laboratory analyses performed on a NAPL sample collected from MW-123 confirm that the observed product here is coal tar with a density of 1.13 and a viscosity at near ambient conditions (50°F) of 633 cSt. This measurement was determined to be equivalent to 13.1 cSt at 122°F (for comparison with NAPL samples collected during the RI) using the three-point temperature measurements conducted for viscosity. The interfacial tension for this NAPL was measured at 16.65 dynes/cm. These values are very similar to those observed for NAPL at NZ-2 from monitoring well MW-116B. The presence of 14.2 feet of NAPL within MW-123 after its installation in November 2008 suggests that NAPL saturations in this portion of NZ-4 are elevated.

NZ-5

NZ-5 is composed of a deep NAPL present in the southeastern portion of the former Celotex property, from the shoreline up to 130 feet towards the west and 120 feet north of the Quanta/former Celotex property boundary (Figure 3-8). In the absence of the wooden bulkhead, which ends at the Quanta property boundary, the NZ-5's lateral extent from east to west is narrower than that of NZ-2. NAPL at NZ-5 has been observed as deep as 40 feet bgs (MW-135), with most of the NAPL residing between 20 and 25 feet bgs. Here, NAPL resides at the interface between the fill and soft organic silt units. Cross-section B-B' in Figure 3-2 and cross-section K-K' in Figure 3-12 illustrates the vertical extent of NZ-5 relative to the shoreline and Site stratigraphy.

Soil borings and monitoring wells were completed at MW-134 and MW-135 to determine the degree to which NZ-5 and NZ-2 are connected. In addition, although NAPL had been observed in borings at the former Celotex property it had not been found to accumulate in monitoring wells. This led to the belief that NAPL at NZ-5 may be strictly residual phase. The installation of MW-134 and MW-135 also addressed this data gap. As illustrated on Figure 3-2, MW-134 and MW-135 have demonstrated that the two shoreline NAPL zones are connected. However, thicknesses of NAPL at NZ-5 are significantly less than those at NZ-2. Product has accumulated in monitoring well MW-135 (0.8 foot), which confirms the presence of free-phase NAPL. However, the sum of measured thicknesses here suggests lower NAPL saturation levels than those behind the bulkhead to the south at NZ-2, where as much as 12.7 feet of NAPL has been found to accumulate in MW-116B.

Laboratory analyses performed on a NAPL sample collected from MW-135 indicated the presence of a low- to medium-viscosity coal tar with a density of 1.09 and interfacial tension of 5.78 dynes/cm. Viscosity of the NAPL at MW-135 was measured at 38.2 cSt at 50°F, which was determined to be equivalent to 4.9 cSt at 122°F (for comparison with NAPL samples collected during the RI) using the three-point temperature measurements

conducted for viscosity. The interfacial tension and viscosity was the lowest for all NAPL samples collected across the Site with the exception of the sample from MW-107 (NZ-3) (Table 2-11).

NZ-6

Based on additional SRI borings, NAPL Zone 6 was created to include NAPL observed at the intersection of Gorge and River Roads. NAPL had been known to exist near the intersection of Gorge and River Roads from data available from locations SB-12, MW-N1, and MW-N2 at depths of 8 to 15 feet bgs, but because of limited access in the traffic-heavy intersection, data supporting the existence of a contiguous NAPL body was limited. The completion of SB-49, SB-50, SB-54, and MW-126 and on Block 92.01 at SB-52 and SB-58 further delineated this NAPL mass.

NZ-6 is present throughout the intersection of Gorge and River Roads near the former tank farm used during coal-tar-processing and oil-recycling operations. NAPL at NZ-6 extends to the northeast corner of Block 93 North, the southwest corner of the former Celotex property, the northwest corner of the Quanta property, and the southeast corner of Block 92.01. It is present in depth ranging from 8 to 15 feet bgs. Cross-sections E-E', F-F', and G-G', shown in Figures 3-5, 3-6, and 3-7, respectively, illustrate the lateral and vertical extents of NZ-6. NAPL occurs at and just beneath the water table and, similar to NAPL at NZ-1, remains approximately 10 feet above the surface of the silty-clay at the interface between the fill and underlying native sand or peat. Portions of NZ-6 may be connected to NZ-1; however, NZ-6 is characteristically deeper relative to the surface, located beneath the roadway, and also believed to be associated with a different primary source (the storage tanks previously located in this area, shown in Figure 3-8); therefore NZ-6 is being considered separately from NZ-1.

Monitoring well MW-126 was installed within the central portion of NZ-6 screened within the most NAPL-impacted depth interval. To date, NAPL has not accumulated within MW-126, suggesting that NAPL saturation levels in this area are lower than in the other NAPL zones and are not sufficient to promote entry of the NAPL into the well, at least in the short-term.

4.1.4 Mobility

NAPL mobility is dependent upon the following soil and fluid characteristics:

- Fluid viscosity
- Fluid density
- Interfacial tension
- Subsurface temperature
- Soil capillarity
- Lithologic interfaces/capillary barriers
- Fluid saturation
- Residual saturation
- Relative permeability
- NAPL pressure/gradient

NAPL mobility and distribution is density driven and controlled largely by the NAPL viscosity and the lithologic interfaces and capillary barriers, because most NAPL is denser than water and typically immiscible and nonwetting. As such, it can be found accumulated at lithologic interfaces where NAPL pressure, or the displacement pressure, is insufficient to exceed the pore entry pressure of the underlying unit. NAPL saturation and thickness are found at their highest along these interfaces. The mobility of NAPL may also be affected by

other constituents (e.g., petroleum products) that can affect the characteristics listed above. As described in the RI Report and in Section 4.1.2 of this SRI report, the NAPL is naturally contained by gravitational forces and the architecture of these key stratigraphic interfaces. The SRI has resulted in the collected of additional data in support of this conclusion. These findings are further detailed below.

Continued releases of NAPL are no longer occurring at OU1; however, the duration of NAPL mobility after cessation of a release is highly variable and dependent upon the time it takes the NAPL pressure to equilibrate with the soil pore entry pressure. A large portion of the NAPL at OU1 has an elevated viscosity that has limited its lateral movement to areas adjacent to former primary source areas (e.g. historic storage tanks) (Figure 3-8). This same combination of NAPL and subsurface soil conditions has also prevented its vertical migration beyond the fill unit several feet below the water table. In the absence of continued primary sources that could serve to increase the displacement pressure of the NAPL this NAPL will remain immobile. At other areas of the Site where lower viscosities and/or higher NAPL saturation levels have resulted in additional vertical migration, NAPL mobility is limited by undulating lower-permeability stratigraphic units such as the silty clay or in the case of shoreline areas, the organic silts. NAPL here tends to accumulate higher saturation levels at these interfaces and has been found in inland areas to pool in the depressions along the surface of these low-permeability units.

Provided that the volume of any residual, migrating NAPL in the overlying soil is not sufficient to overcome the edges of these low spots, further lateral and vertical migration of this NAPL will not occur. If this were to occur the presence of significant thicknesses of organic silt deposits downgradient would serve as a barrier against migration to the surface water or sediments. Along the shoreline areas where NAPL saturations are highest at the interface between the fill and underlying organic silts NAPL is estimated to be mobile as it may be continuing to migrate in the down-dip direction along this surface, at least until another barrier is encountered.

Although movement can be very slow for high-viscosity NAPLs such as those observed in NZ-1 and portions of NZ-2, full equilibration can be expected to continue for multiple decades (Jackson et al., 2004). Extremely slow moving NAPLs (conductivities of less than 1×10^{-6} cm/sec) are considered immobile (ASTM, 2006). It is also important to note that changes in any of the characteristics mentioned above may result in a shift in NAPL architecture and may result in a change in NAPL mobility if and where lithologic and capillary barrier conditions allow.

The following sections provide a qualitative evaluation of NAPL mobility for each of the NAPL zones at the Site. This involves an examination of the physical characteristics of the various NAPLs (Table 2-11), observations of the subsurface distribution and at the shoreline, and measured thicknesses within monitoring wells, and a detailed understanding of Site stratigraphy.

NZ-1

At NZ-1, measured viscosities (at 122°F) ranging from approximately 14.3 to 61.2 cSt limit the mobility of NAPL and prevent it from penetrating the less-permeable native silty sands directly beneath the base of the fill. Significant lateral migration has not been observed and

would not be expected given the elevated viscosity of the NAPL and the absence of significant hydraulic gradients observed here.

High viscosity and interfacial tension have generally limited the downward vertical migration of NAPL to 11 feet bgs or less. Further migration is not predicted to occur, given the physical characteristics of the NAPL that resulted in the presence of NAPL at NZ-1. As described in Section 4.1.3, an isolated area of NAPL exists within NZ-1 to depths of up to 25 feet bgs. However, the presence of NAPL here is believed to be the result of the placement or removal of a former UST, which resulted in the disturbance of subsurface conditions, localized removal of native sands and subsequent replacement with greater thicknesses of fill deposits. NAPL has not migrated laterally beyond this area (Figures 3-1 and 3-4).

NZ-2

At NZ-2, adjacent to the wooden bulkhead, measured NAPL viscosities (at 122°F) span a wide range (27 cSt for NAPL at MW-116B to 182 cSt at MW-105). In addition, the measurement of NAPL between approximately 10 (MW-105 and MW-105A) and 12.7 feet (MW-116B) indicates that NAPL saturation is sufficient to produce free-phase or mobile NAPL in these areas. Furthermore, unlike in the inland areas, controlling stratigraphic units (e.g., the upper sand unit and top of the soft organic silt) dip toward the river (Figure 3-12). This combination of factors suggests that at least portions of the NAPL at NZ-2 may be characteristic of a mobile material.

The wooden bulkhead at the shoreline of the Quanta property and 115 River Road provides a physical hydraulic impediment between OU1 and OU2. Evidence for this is presented and discussed in Section 3.2.2. The geophysical survey discussed in Appendix W has shown that the base of the wooden bulkhead is at an elevation of approximately -22 to -25 feet msl, slightly deeper than the deepest NAPL, at -19 feet msl observed at the shoreline (MW-116DS). The wooden bulkhead is present in most of the shoreline areas where NAPL has been observed at NZ-2. This structure likely is a significant barrier to NAPL migration from NZ-2 to OU2. However, given the presence of NAPL in the nearshore sediments of OU2 at elevations similar to those immediately adjacent to the bulkhead in OU1 (GeoSyntec, 2000; CH2M HILL, 2007d), as well as the observed presence of NAPL at the sediment surface of OU2 (Appendix Z), it cannot be assumed that the bulkhead serves as a complete barrier to NAPL movement from OU1 to OU2. The distribution of NAPL at the flanks of the bulkhead and the presence of less-viscous NAPL to the north at NZ-5 (MW-135) suggest that the more mobile forms of NAPL have seeped northward around the bulkhead along the surface of the less-permeable organic silts. This seepage is primarily a function of the downward sloping surface of the organic silt-fill interface, the physical characteristics of the NAPL, and to a lesser extent the hydraulic forces resulting from the presence of the bulkhead.

In the southern portion of NZ-2, where the bulkhead is not present, NAPL thicknesses and thus NAPL saturation levels are greatly diminished. Furthermore, NAPL has not accumulated in monitoring well MW-106, which is screened within the interval of NAPL along the southern edge of NZ-2 since its installation in 1998. This fact, in addition to the relatively low levels of Site-related organic constituents in groundwater observed at this location, suggests that Site-related NAPL near the northeast corner of the former Lever Brothers property is residual and currently immobile.

NZ-3

The lower interfacial tension (8.2 dynes/cm²) and viscosity (3.49 cSt) of the NAPL sample collected at MW-107 suggest that this NAPL was able to overcome the pore pressures associated with the shallow fill and native sand units to migrate downward and laterally until reaching a natural depression in the top of the undulating surface of the silty-clay confining layer, which prevents further vertical migration.

Throughout most of NZ-3, the silty clay confining layer unit slopes up to create the natural depression that prevents lateral migration of the NAPL (Figure 3-9). However, historic geotechnical borings 1948-9 and 1948-10, which were completed in the northeast portion of the former Lever Brothers property, indicate that the silty clay dips downward toward the south and east (Figure 3-6). Along this edge of NZ-3, NAPL is present only as thin and discontinuous lenses. To date, NAPL does not appear to have migrated beyond the edge of this downslope. If additional lateral migration of the NAPL associated with NZ-3 were to occur, the physical characteristics of the NAPL indicate that it would continue to migrate downward, following the surface of the silty-clay to depths of at least 75 feet bgs. Upward migration through the sediments and into surface waters would not be expected to occur due to its density and the presence of significant thickness of low permeability organic silt.

NZ-4

Despite elevated saturation levels experienced in the NAPL observed at monitoring well MW-123, NAPL at NZ-4 has an elevated viscosity (13.1 cSt at 122°F) and interfacial tension (16.65 dynes/cm²). These characteristics suggest that the NAPL is immobile. Furthermore, the stratigraphic setting here provides a barrier to any future potential lateral or vertical movement of this NAPL zone. In all directions along the periphery of NZ-4 a consistent rise in the elevation of the peat and silty clay is present preventing further lateral migration (Figure 3-5 and 3-9). NZ-4 remains at a significant distance from OU2 and will not have the ability to reach OU2.

NZ-5

The accumulation of NAPL in monitoring well MW-135, located north of the wooden bulkhead, is evidence that free-phase product is present at NZ-5. Laboratory analytical results indicate that NZ-5 NAPL has a relatively low viscosity (4.9 cSt at 122°F) and interfacial tension (5.78 dynes/cm²). Based on these characteristics, the material appears to be mobile. The NAPL appears to follow the downward sloping interface between the base of the fill and the organic silt deposit; the bulkhead is absent in this area and NAPL has been observed in OU2 at similar elevations within in the sediments and at the sediment surface (Appendix Z).

NZ-6

To date, NAPL has not been observed to accumulate in monitoring wells screened within NZ-6 (MW-126 and MW-N-2) which would allow for NAPL to be sampled. As a result, the specific characteristics of NAPL in this zone cannot be determined. Cross-sections E-E', F-F', and G-G', provided in Figures 3-5, 3-6, and 3-7, respectively, illustrate that NZ-6 is trapped at the interface of fill and native sand, where it has not been able to overcome the pore pressures and migrate further downward to the surface of the silty-clay. This is consistent

with the description of the presence of a low-viscosity NAPL in the boring logs for MW-126 and SB-49. Its limited lateral extent beyond the footprint of the former tank farm also indicates that lateral migration from the former primary source has been minimal. Furthermore, the plan view depiction of the silty-clay surface contours provided in Figure 3-9 suggest that if vertical migration of NZ-6 were to occur, it would be physically contained by the natural depression in the silty clay surface present in this portion of the Site. NZ-6 remains at a significant distance from OU2 and will not have the ability to reach OU2.

4.2 Nature and Extent in Soil

When the RI Report was submitted in August 2008, the extents of Site-related NAPL and coal tar constituents in soil had not been fully defined to the west of River Road near Blocks 93 North, Central, and South; the northwest portion of the former Lever Brother's property; and at the intersection of Gorge and River Roads. A component of Objective 1 of the SRI Work Plan was to determine the nature and extent of Site-related constituents in soil in these areas. Based on the results of additional soil sampling performed during the SRI, these remaining data gaps have been addressed.

To evaluate and discuss the nature and extent of constituents in soil samples collected at the Site as part of the SRI, laboratory analytical results for all chemical constituents were screened against the following applicable soil screening criteria:

- New Jersey Residential Soil Cleanup Criteria (NJDEP, 2009)
- New Jersey Nonresidential Soil Cleanup Criteria (NJDEP, 2009)
- EPA Regional Industrial Soil Screening Levels for Chemical Contaminants at Superfund Sites (EPA, 2008b)
- EPA Regional Residential Soil Screening Levels for Chemical Contaminants at Superfund Sites (EPA, 2008c)

As part of the RI Report, data were screened using the draft NJ Soil Cleanup Criteria (residential, nonresidential, and impact to groundwater) and EPA Region 9 Preliminary Remediation Goals (residential and industrial). However, in 2008, these sets of criteria were revised or replaced. In 2008, NJDEP promulgated residential and nonresidential soil cleanup criteria and eliminated the impact-to-groundwater soil-cleanup criteria. For several constituents, the promulgated residential or nonresidential standard was modified from the value presented in the draft soil cleanup criteria. The 2004 EPA Region 9 Preliminary Remediation Goals were replaced in September 2008 by the EPA Regional Soil Screening Levels for Chemical Contaminants at Superfund Sites. To maintain consistency with the RI Report, a separate screening of constituents in soil samples collected during the SRI was conducted against the same criteria that were used during the RI to determine a list of constituents of potential concern (COPCs) and ultimately address all the appropriate constituents as part of the updates to the human health risk characterization. The results of this effort as are discussed in detail in Section 7.

All SRI soil data were compared to the screening criteria listed above, which are summarized in Table 4-1. Table 4-2 lists the constituents exceeding EPA or state screening levels in soil for PAHs, non-PAH SVOCs, VOCs, inorganics, and PCBs and summarizes the screening results for each SRI soil sample collected. The constituents exceeding EPA or state screening levels listed in Table 4-2 include compounds present because of historical Site activities as well as from non-Site-related sources, including fill and releases that have occurred as the result of operations at adjacent properties, as described in Section 4.1 of the RI Report (Appendix A). Laboratory analytical results tables for all SRI soil samples evaluated in this report are provided in Appendices E through K. Copies of the analytical laboratory reports for the soil samples are included in Appendix S.

This section updates the presentation on the distribution of Site-related constituents in soil found in Section 4.3 of the RI Report. As with the RI, discussions on the constituents in soil related to former operations associated with OU1, including oil recycling and coal tar operations, focus on select representative organic compounds that include benzene, benzo(a)pyrene, naphthalene and PCBs. Each figure illustrating the distribution of these constituents in both unsaturated (generally less than 4 feet bgs) and saturated (generally greater than 4 feet bgs) soil, that was provided in the RI, has been updated and included as part of this report and is discussed in the following subsections relative to areas where data gaps were identified. Additional data gaps related to the distribution of arsenic in soil at the Site that were also identified in the SRI Work Plan have also been addressed similarly and are discussed separately in Section 5. Comprehensive discussions in the RI Report on the nature and extent of all Site-related constituents in soil remain relevant and applicable unless otherwise noted herein.

4.2.1 Block 93 (North, South, and Central)

The SRI has been successful in completing the characterization of soil conditions west of River Road at Blocks 93 North, Central, and South. Figures 4-2 through 4-9 present revised isoconcentration contours for each of the representative Site-related constituents (benzene, benzo(a)pyrene, naphthalene, and PCBs) for unsaturated soil (less than 4 feet bgs) and saturated soil (greater than 4 feet bgs). These figures include all available soil data, including those collected most recently as part of the SRI.

Within the saturated soil zone (4 feet bgs and deeper), elevated concentrations of benzo(a)pyrene, naphthalene, and benzene (shown in Figures 4-3, 4-7, and 4-5, respectively) correlate well with the extents of NAPL west of River Road at NZ-1 and NZ-4 (shown in Figure 3-8). Higher concentrations appear to extend from the western portion of the 115 River Road property and the northwest portion of the former Lever Brothers property, across River Road, and into Blocks 93 South and Central. These constituents are present in saturated soil to the west as far as the central portions of these two properties. Beyond the central portions of the two properties, benzo(a)pyrene concentrations are significantly reduced and are present at concentrations consistent with the historic fill throughout the area. Naphthalene in saturated soil in the western portions of these properties is consistently below the lowest applicable screening criterion of 3.9 mg/kg (EPA Regional Residential Soil Screening Criteria), and benzene is nondetect. As in Blocks 93 South and Central, benzene in the saturated soils does not extend farther west than the central portion of this property. However, unlike benzene, PAHs in saturated soil extend farther west at Block 93 North than

they do to the south and are present above screening criteria throughout most of this property up to and beyond the edge of Old River Road. The southern limits of Site-related constituents in saturated soil along River Road and at the edge of the Block 93 South property have also been defined and do not extend further south than the southeastern corner of the Medical Arts building. Beyond the western extents of Site-related constituents in saturated soil at Block 93 Central, a petroleum odor was observed at a depth of 5 to 8.5 feet bgs during the completion of the boring at MW-127. TPH fingerprinting results for a sample collected from this interval indicated the presence of low levels of petroleum hydrocarbons consistent with fuel oil. Based on the available data, it is reasonable to conclude that these localized conditions are not related to historical operations associated with OU1.

Samples from the unsaturated soil zone (0 to 4 feet bgs) show that elevated concentrations of the more volatile aromatic VOCs are limited to the southeast corner of Block 93 North. PAHs in the shallower soils are more extensive and are present within the unsaturated soil throughout most of Block 93 North and the northern portions of Block 93 Central, where they extend up to and beyond the edge of Old River Road to the west. An isolated occurrence of PAHs above their screening criteria to the south at Block 93 South was observed at TL10.5-10.5. This sample was collected at the water table at a depth of 3.5 to 4.0 ft bgs and appears to have been affected by the presence of elevated concentrations of these constituents within the saturated zone as illustrated in Figures 4-3 and 4-7.

As part of the comprehensive characterization of soil conditions at the Blocks 93 South and Central properties where data had not previously been collected, soil samples were also analyzed for PCB Aroclors. Results of these analyses are presented in Figures 4-8 and 4-9. All soil samples collected from both the saturated and unsaturated soils at Blocks 93 South and Central were below the laboratory method detection limits for PCB Aroclors, with the exception of detections of Aroclors 1254 and 1260 of 1.09 and 0.67 mg/L, respectively, at TL10.5-10.5 at a depth of 0 to 1 foot bgs. No oil-recycling activities were documented to have taken place on this block; therefore, the observed PCB concentrations in soil at this location are not believed to be related to site operations.

4.2.2 Block 94

To the west of Blocks 93 North and Central, work performed as part of the SRI has confirmed the presence of Site-related constituents in soil within the eastern portions of this property at the foot of the Palisades. The SRI has been successful at defining the extent of these constituents to the west of the Site at Block 94. Although Site-related NAPL does not extend to this property, the presence of solid tar observed within the fill at MW-128 at and just below the water table at a depth of 2 to 4 feet bgs has resulted in the presence of naphthalene above the lowest applicable screening criterion (3.9 mg/kg) at concentrations between 17.1 and 1,900 mg/kg. Other PAHs, such as benzo(a)pyrene, are also present here, between 431 and 838 mg/kg, which are concentrations above that typically observed because of the presence of historic fill.

Further south, at MW-129, where fill thicknesses diminish, lower concentrations of naphthalene and benzo(a)pyrene as high as 12.9 and 32.1 mg/kg, respectively, are observed as far as MW-128. Both MW-128 and MW-129 lie north of SB-39, at which no elevated concentrations of Site-related constituents were observed.

Benzene and other aromatic hydrocarbons were detected in the soil at Block 94 (Figures 4-4 and 4-5) at only very low concentrations, and with the exception of one detection of ethylbenzene at MW-128 at a concentration of 18.9 mg/L these constituents were all below their lowest applicable screening criteria. This is a result of the weathered nature of solid tar observed at this location.

Although additional soil sampling was not conducted west of MW-128 and MW-129 as part of the SRI, the western extents of Site-related constituents in soil can be inferred to extend only another 25 to 75 feet farther west of these locations, where the Palisades bedrock formation outcrops.

PCB Aroclors were not found above laboratory method detections limits in any saturated or unsaturated soil samples collected at Block 94 during the SRI or within the western portions of Block 93 during the RI. The extents of PCBs in saturated and unsaturated soils in the western portions of the Site were fully defined as part of the RI and the depictions presented in Figures 4-8 and 4-9 near this property remain consistent with those presented and discussed in the RI Report.

4.2.3 Gorge Road–River Road Intersection

The SRI has been successful in completing the characterization of soil conditions northwest of the current Quanta property within the intersection of Gorge and River Roads. Soil samples collected in this area during the SRI indicate the presence of Site-related constituents in saturated soils above the lowest applicable screening criteria. The lateral and vertical extent of these exceedances correlate well with the presence of NZ-6, which appears to have been the result of releases associated with the former tank farm in this area (Figure 3-8). Elevated levels of PAHs were found in soils greater than 4 feet bgs at elevations corresponding with observations of NAPL. Specifically, naphthalene was detected at these intervals at MW-126, SB-49, and SB-59 between 1,220 and 5,360 mg/kg. Soil samples collected from SB-12, -14, and -15 (during the SRI) and SB-51, -52, and -58 show that these Site-related constituents are not present farther north in Block 92.01 or northeast beyond the southwest corner of the former Celotex property. The presence of benzene, which is relatively soluble and volatile, is not widespread within the intersection of Gorge and River Roads. In this area, the only sample in which benzene exceeded the lowest applicable soil criterion (1.1 mg/kg) was along the northwest corner of the Quanta property, at SB-49 from 9 to 10 feet bgs, where it was present at a concentration of 8.1 mg/kg.

The soil at SB-49 between 9 and 10 feet bgs also represents the only sample location within River Road where PCBs were detected above the lowest screening criteria. Here a combination of the PCBs Aroclor 1254 and 1260 were detected at a combined concentration of 4.25 mg/kg. PCBs were also detected in shallower soils west of this location at B-15 (1.2mg/kg), on the northwest corner of the Quanta property. Owing to a steep drop in elevation that occurs towards the Quanta property from SB-49, the results for B-15 are shown in Figure 4-8 because it represents the interval of soil above 4 feet bgs in this lower-lying area. These results are consistent with the RI that showed a contiguous area of PCB concentrations in soil near former unloading areas, centrifuging areas, and storage tanks associated with historical oil-recycling operations.

As illustrated in Figures 4-2, 4-4, 4-6, and 4-8, Site-related constituents, including benzene, naphthalene, benzo(a)pyrene, and PCBs, are not present in soils (less than 4 feet bgs) within the intersection of Gorge and River Roads. This is a result of the topographic surface in this area having been raised as part of the realignment of River Road and the more recent modifications within the intersection in 2003.

4.2.4 Northeast Corner of Former Lever Brothers Property

As described in Section 4.1.3, the southern extents of Site-related NAPL have been defined in the northeast corner of the former Lever Brothers property using the information collected as part of the NAPL delineation. Because of the soil sampling performed in this area during the RI and SRI and by other parties as part of separate environmental investigations, the delineation of Site-related constituents in soil related to OU1 has been completed.

Cross sections Q-Q', R-R', and S-S' in Figure 4-1 illustrate the relative position of both Site-related pyrogenic sources and various non-Site-related petrogenic sources within the northeast corner of the former Lever Brothers property. The distributions of representative Site-related constituents in both saturated and unsaturated soil are presented in Figures 4-2 through 4-9. Within the unsaturated zone south of 115 River Road along the shoreline, benzene has not been detected in soil. Conversely, the less soluble and volatile PAHs, including naphthalene, are present above screening criteria. Because Site-related NAPL has not been detected within these sampling intervals and evidence at the adjacent eroding shoreline shows the presence of a significant volume of pitch/asphaltic material exists as a component of the fill at similar elevations the presence of these constituents in the unsaturated soil is not believed to be related to OU1.

Within the saturated zone, the presence of Site-related constituents related to OU1 do extend onto the northeast corner of the Lever Brothers property and are found as far south as MW-106A, just beyond the lateral extents of Site-related NAPL and above the base of the fill, at a depth 18.5 to 19 feet bgs. Here concentrations of benzo(a)pyrene and naphthalene are 13 mg/kg and 130 mg/kg, respectively. Unlike with the PAHs, benzene here was below the lowest screening criteria of 1.1 mg/kg, at a concentration of 0.074 mg/kg. However, above this depth at MW-106A, benzene is present at a concentration of 7.7 mg/kg where petrogenic, non-Site-related sources are overlying the Site-related impacts that have been confirmed present. These shallower non-Site-related benzene impacts extend farther south and east along the shoreline, where they are observed at similar concentrations and elevations in samples collected from in TL11.25-00 (11.8 mg/kg) and TL11.75-00 (5.98 mg/kg), where PAHs have not been detected. As discussed in Section 4.1.3 and illustrated in cross section Q-Q' in Figure 4-1, soil conditions here are the result of the presence of a non-Site-related NAPL near MW-106A.

The extents of PCBs in saturated and unsaturated soils in the northeast corner of the former Lever Brothers property were fully defined as part of the RI process, and the depictions are presented in Figures 4-8 and 4-9. The PCB concentrations observed there are believed to be associated with operations on the former Lever Brothers property.

The lateral and vertical extents of NAPL and coal tar constituents south of 115 River Road along the shoreline have been determined through careful delineation involving the

completion of numerous TarGOST® and conventional soil borings, and the collection and analysis of soil samples for VOCs and SVOCs and for petroleum hydrocarbon fingerprinting. These extents can now be discerned from those that are a result of releases associated with historical operations at the former Lever Brothers property.

4.3 Nature and Extent in Groundwater

Upon submittal of the RI Report in August 2008, the extents of Site-related NAPL and coal tar constituents in groundwater had not been fully defined west of River Road near Blocks 93 Central and South, Block 94, and in the intersection of Gorge and River Roads. A component of Objective 1 of the SRI Work Plan was to determine the nature and extent of Site-related constituents in groundwater in these areas. Furthermore, as part of SRI Objective 8, additional data were collected for pore water and surface water at OU2 to better understand the distribution of coal tar- and NAPL-related constituents across the groundwater-surface water transition zone(s) between OU1 and OU2. Based on the results of additional soil sampling performed during the SRI, these remaining data gaps have been addressed.

To evaluate and discuss the nature and extent of constituents in groundwater at the Site as part of the SRI, laboratory analytical results for all chemical constituents were screened against the following applicable groundwater-screening criteria:

- The higher of the Groundwater Quality Criterion and the Practical Quantitation Limit presented for each constituent in Appendix Table 1 of Chapter 7:9C of the NJAC was used; for those constituents not currently having a GWQS, an interim generic groundwater quality criterion was used according to NJAC Section 7:9C-1.7 (C)(6)
- EPA Regional Screening Levels for Tap Water (EPA, 2009b)
- EPA Maximum Contaminant Levels from Primary Drinking Water Regulations (EPA, 2002)

As part of the RI Report, groundwater data were screened against the 2004 EPA Region 9 Preliminary Remediation Goals for tap water. However, in September 2008 the Region 9 Preliminary Remediation Goals were replaced by the EPA Regional Screening Levels for Chemical Contaminants at Superfund Sites. To maintain consistency with the RI Report, a separate screening of constituents in groundwater samples collected during the SRI was conducted against the same criteria used during the RI to determine a list of COPCs and ultimately address all the appropriate constituents as part of the updates to the human health risk characterization. The results of these efforts are discussed in detail in Section 7.

One of two semiannual groundwater-sampling events planned as part of SRI activities will have been completed by the time this SRI Report is submitted. A second event is scheduled for completion in September 2009. In accordance with the SRI Work Plan, these additional data will be provided and summarized under separate cover. For the purpose of this assessment, all SRI groundwater data from the first of the two events were compared to the lowest of the applicable screening criteria from those indicated and those exceeding the lowest applicable criteria are summarized in Table 4-3.

The constituents exceeding EPA or state screening levels listed in Table 4-4 consist of SVOCs (predominantly PAHs), VOCs (aromatic VOCs and chlorinated VOCs), arsenic, cadmium, iron, and manganese. These include compounds present because of historical Site activities and non-Site-related sources, including fill and releases that have occurred as the result of operations at adjacent properties, as described in Section 4.1 of the RI Report (Appendix A). In general, the distribution of Site-related coal tar and NAPL constituents (SVOCs and aromatic VOCs) is consistent with the distribution of NAPL described in Section 4.1.2 of this report. Laboratory analytical results tables for all SRI groundwater samples evaluated in this report are provided in Appendices M through R. Copies of the analytical laboratory reports for groundwater samples are included in Appendix S.

This section updates the presentation of the distribution of Site-related constituents in groundwater provided in Section 4.4 of the RI Report. As with the RI, discussions on the constituents in groundwater related to former operations associated with OU1 focus on select representative organic compounds, including benzo(a)pyrene, benzene, naphthalene, and dibenzofuran.¹ The figures illustrating the distribution of these constituents in groundwater that were provided in the RI have been updated and included in this report as Figures 4-10 through 4-13 and are discussed in the following subsections relative to those areas where data gaps were identified. These areas include Blocks 93 South and Central, Block 94, the Gorge Road–River Road intersection, and the groundwater–surface water transition zone downgradient of OU1.

Additional data gaps related to the distribution of arsenic in groundwater at the Site that were also identified in the SRI Work Plan have also been addressed similarly and are discussed separately in Section 5. Comprehensive discussions in the RI Report on the nature and extent of all Site-related constituents in groundwater remain relevant and applicable unless otherwise noted herein.

4.3.1 Block 93 (Central and South)

The SRI has been successful in completing the characterization of groundwater conditions west of River Road at Blocks 93 Central and South and determined the extent of Site-related constituents in groundwater. None of the Site-related indicator constituents that were previously contoured and discussed in the RI Report (benzo(a)pyrene, benzene, naphthalene, and dibenzofuran) were detected above their respective screening criteria in groundwater.

To maintain consistency with the RI Report (Appendix A), benzo(a)pyrene and naphthalene concentrations were contoured because they show the range of distribution for PAHs in groundwater, and represent heavy- and light-end PAHs, respectively. As shown in Figures 4-10 and 4-12, elevated concentrations of both compounds do not extend much beyond the current boundaries of NAPL zones NZ-1or NZ-4. Benzo(a)pyrene has not typically been found downgradient of NAPL extents at the Site; however, naphthalene has historically been observed beyond the NAPL extent, as stated in the RI Report (Appendix A). Both compounds exceed their respective groundwater-screening levels at only MW-123 and MW-136, which are

¹ Currently, no applicable screening criteria exist for dibenzofuran. To maintain consistency with the RI report this constituent was retained as a representative constituent and contoured in groundwater relative to the EPA Region 9 Screening Criteria for tap water (12 µg/L).

the easternmost locations on Blocks 93 Central and South. The concentration of naphthalene is highest in MW-123 (10,500 µg/L), where NAPL has been observed to accumulate.

Dibenzofuran had been used to represent the extent of non-PAH SVOC impacts in groundwater at OU1 in the RI Report (Appendix A). Although there is no longer an applicable screening criterion, isoconcentration contours (Figure 4-13) were developed using data collected during the SRI to maintain consistency with the RI Report and complete the evaluation of the extent of non-SVOC impacts in groundwater that was initiated as part of the RI. At Blocks 93 Central and South the extents of dibenzofuran is similar to that of naphthalene. The highest observed concentration for this constituent was 196 µg/L, at MW-123.

BTEX compounds are the most frequently detected VOCs in Site groundwater. As was the case in the RI benzene was contoured and discussed to evaluate the extent of Site-related volatile constituents as it is the most abundant and soluble of these constituents and would be expected to be the most widespread. The extent of benzene in groundwater is concentrated at the eastern edge of Blocks 93 Central and South near NZ-4, with exceedances observed in MW-136 and MW-123. The highest concentration of benzene in this area (423 µg/L) was observed in the sample collected from MW-123, where thicknesses of NAPL have been found to accumulate.

No PCB compounds were detected in groundwater samples collected at Block 93. This was consistent with the findings of the RI Report.

4.3.2 Block 94

The SRI has successfully characterized groundwater conditions west of Old River Road at Block 94. Isoconcentration contouring for the compounds benzo(a)pyrene, dibenzofuran, and benzene (Figures 4-12, 4-10, 4-13, and 4-11, respectively) show that these compounds are not present in groundwater above screening criteria on Block 94. Only very low levels of naphthalene (0.445 µg/L) and benzo(a)anthracene (0.281 µg/L) were detected in groundwater samples collected at this property above the lowest screening criteria. No NAPL was observed within soil samples collected at Block 94, and only solid tar impacts were present in shallow soils at MW-128. Due to the weathered nature of the solid tar, it does not represent a source to groundwater. Block 94 is beyond the extent of Site-related constituents in groundwater associated with OU1.

VOCs in groundwater observed included only chlorinated compounds at MW-128 and MW-129 and are the result of upgradient sources unrelated to the Site, as stated in the RI Report (Appendix A). Detections of PCE (10.5 µg/L) and TCE (52.3 µg/L) at the sample collected at MW-128 during the SRI represent the highest levels of these constituents observed in shallow groundwater (above the silty clay layer) to date. As shown in Figure 3-16, shallow groundwater at Block 94 is hydraulically upgradient of Block 93 and the areas of former industrial operations associated Quanta property.

No PCB compounds were detected in groundwater samples collected at and adjacent to Block 94. This was consistent with the findings of the RI Report.

4.3.3 Gorge Road–River Road Intersection

A component of SRI Objective 1 was to determine the nature and extent of NAPL and coal tar constituents in the intersection of Gorge and River Roads. The SRI has successfully characterized groundwater conditions within the intersection of Gorge and River Roads. Naphthalene and benzene are present above their respective screening criteria in groundwater at MW-126 where NAPL has been observed; the less-soluble benzo(a)pyrene was not detected here.

To the north, on Block 92.01 at MW-L, key indicator compounds were not detected with the exception of naphthalene (1.67 µg/L) which was above the EPA RSL for tap water (0.14 µg/L), but well below the New Jersey Groundwater Quality Standards (NJGWQS) of 300 µg/L. Likewise, along the western extents of observed NAPL within the intersection, the sample collected from 3Y-MW2 also had no detectable concentrations of these parameters with the exception of a similar concentration of naphthalene (2.45 µg/L). Elevated concentrations of Site-related constituents in groundwater do not extend beyond the bounds of NZ-6 NAPL in this area.

No PCB compounds were detected in groundwater samples collected within the Gorge Road–River Road intersection. This was consistent with the findings of the RI Report.

4.3.4 Nearshore Groundwater and Pore Water

To characterize the distribution of dissolved phase constituents downgradient of OU1, pore water samples and collocated surface water samples were collected at the five locations within OU2 where groundwater upwelling was deemed most likely to be occurring. The rationale for selecting the location of the pore water and surface water samples is described in detail in Section 3.3.3. Deeper pore water samples were also collected from shallow (5 feet bss), intermediate (15 feet bss) and deep (25 feet bss) piezometer nests within OU2 when the yield was sufficient. The location of shallow pore water/surface water samples GWZ-1 through GWZ-5 and the OU2 nested piezometer clusters PZ-1 through PZ-5 are illustrated in Figure 2-1. With the exceptions noted below, all deep and shallow pore water and surface water samples were analyzed for VOCs and SVOCs for the purpose of evaluating the nature and extent of NAPL and coal tar constituents. Site related PAHs, non-PAH SVOCs and aromatic VOCs were detected in one or more of the nearshore shallow pore water, deep pore water and surface water samples collected during the SRI. These constituents were not detected within the shallow pore water or surface water samples collected at identified groundwater upwelling zones farther from the shoreline (GWZ-3 and -4). The presence of these constituents in nearshore areas is a function of the migration of dissolved constituents from OU1 groundwater as well as the presence of additional secondary sources of NAPL and adsorbed phase constituent sources in these areas at OU2. Total BTEX and total PAH results for each of these samples are shown in context of the results for nearshore groundwater in Figure 4-14. In addition, analytical results for the individual representative constituents benzo(a)pyrene, benzene, naphthalene, and dibenzofuran are shown in context of the Site-wide groundwater analytical results in Figures 4-10 through 4-13.

PAH compounds were detected only at nearshore shallow pore water sampling locations GWZ-1 and GWZ-5. However, it should be noted that the pore water sample collected from the third nearshore location GWZ-2 (north of the bulkhead) was not analyzed for SVOCs

owing to laboratory error. The total PAH concentration was greatest in the shallow pore water at GWZ-1, which also contained detectable concentrations of carbazole and dibenzofuran, both of which are present in relatively high concentrations in upgradient well MW-116B. PAHs were detected at low levels in surface water at two locations, GWZ-1 (28 µg/L total PAHs) and GWZ-5 (2 µg/L total PAHs). Carbazole was also detected at low concentrations in the surface water collected from GWZ-1.

Volatile organic compounds, primarily BTEX compounds, were detected only in the nearshore shallow pore water samples collected at GWZ-1 and GWZ-2, adjacent to and north of the bulkhead. Furthermore, VOCs were detected in surface water only at location GWZ-1, where the total BTEX concentration was 3 µg/L. Analytical results for the individual representative constituents benzo(a)pyrene, benzene, naphthalene, and dibenzofuran are shown in context of the Site-wide groundwater analytical results in Figures 4-10 through 4-13.

The deeper pore water samples collected from one or more of the piezometers within each of the nests indicate the presence of additional sources of dissolved coal tar and NAPL constituents are present with the surrounding nearshore sediments at OU2. Total BTEX and total PAHs were observed in the deeper nearshore pore water at concentrations as high as 12,600 µg/L at PZ-3S and 26,900 µg/L at PZ-1D, respectively, and constituents like benzene and naphthalene in the deeper pore water samples collected at these locations as well as at PZ-4I were sometimes higher than those observed in the upgradient nearshore groundwater at OU1. It should be noted that the presence of NAPL within the small diameter tubing of the PZ-4D piezometer (screened at approximately 25 feet bss) prevented the collection of a pore water sample from this location.

The significance of the shallow pore water and surface water results and the potential risk that they pose to potential receptors within OU2 is being evaluated as part of a Baseline Ecological Risk Assessment (BERA) being performed for OU2. For the purpose of the SRI a preliminary screening of shallow pore water and surface water results against the following screening criteria was performed (Table 4-5):

- Toxicological Benchmarks for Screening Potential Contaminants of Concern from the ORNL Environmental Restoration Program (Suter and Tsao, 1996)
- NOAA Screening Quick Reference Tables (Buchman, 2008)
- New Jersey Surface Water Quality Standards, NJAC Section 7:9B
- New York Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations from Technical and Operational Guidance Series 1.1.1
- EPA Region III Freshwater Screening Benchmarks (EPA, 2009c)
- EPA Region III Marine Screening Benchmarks (EPA, 2008d)

These screening criteria for NAPL constituents were exceeded in pore water and surface water at GWZ-1 and GWZ-5, which are both adjacent to the shoreline (Figure 2-5). The greatest frequency of exceedances was observed at GWZ-1, where the concentrations of toluene, ethylbenzene, and xylenes were greater than the screening criteria; VOCs detected in the surface water at this location did not exceed screening criteria. Fifteen PAHs and two

SVOCs were found also in elevated concentrations in pore water at this location; the associated surface water had exceedances for 11 PAHs and one SVOC.

At GWZ-5, additional exceedances of SVOC and PAH compounds were observed in both pore water and surface water (Table 4-5). All eight exceedances in pore water at GWZ-5 were PAHs; five of these constituents were also elevated in the collocated surface water, along with the SVOC bis(2-ethylhexyl)phthalate.

The shallow pore water and surface water samples collected farther from the shoreline at GWZ-3 also had exceedances of bis(2-ethylhexyl)phthalate. No other constituents were observed at elevated concentrations in either pore water or surface water at this location or at the other off-shore groundwater upwelling zone associated with GWZ-4. At GWZ-2, because of laboratory error, pore water analysis for SVOC constituents was not completed; and thus only surface water results were available for this location. The only estimated exceedance for surface water sample collected at GWZ-2 was for bis(2-ethylhexyl)phthalate. The low concentrations of bis(2-ethylhexyl)phthalate measured in the pore water and surface water throughout OU2 are not related to Site activities; this compound is ubiquitous in the general environment because of its widespread use as a plasticizer in PVC products (IARC, 2000).

As mentioned previously, the potential risk for all constituents in shallow pore water and surface water will be evaluated as part of the BERA being performed for OU2. The comparison of pore water results and to a lesser extent surface water results against the screening criteria outlined above is a conservative means with which to discuss these data for the purpose of the SRI Report.

4.4 Fate and Transport in Groundwater

The factors affecting the migration of NAPL and coal tar-related constituents in both soil and groundwater are presented and discussed in detail in Section 5.5 of the RI Report (Appendix A). This section is intended to supplement and refine the understanding of the fate and transport of NAPL and coal tar constituents that were identified in the RI Report and summarized in the approved SRI Work Plan. Specifically, as part of SRI Objective 6, additional data were collected from a number of existing monitoring wells across the Site as part of the SRI to evaluate the stability of organic constituents in groundwater through an evaluation of the concentration trends of key NAPL and coal tar constituents over time. Furthermore, as part of SRI Objective 8, pore water and surface water samples were collected at identified groundwater upwelling zones to confirm the effects of attenuation on NAPL and coal tar constituents between nearshore upland groundwater and downgradient discharge zones within OU2. The following subsections present an evaluation of each of the specific fate and transport data gaps discussed above and address the relevant components of SRI Objectives 6 and 8.

Data gaps related to the fate and transport of arsenic in groundwater at the Site that were identified in the SRI Work Plan have also been addressed separately in Section 5. Comprehensive discussions in the RI Report on the fate and transport of all Site-related constituents in groundwater remain relevant and applicable unless otherwise noted herein.

4.4.1 Plume Stability

Using historical data as well as newly collected SRI data from existing monitoring wells within and at the periphery of OU1, the stability of the dissolved phase groundwater plumes for key indicator parameters was evaluated across all portions of the Site (central, western, southern, and northern).

Concentrations of naphthalene and benzene, which represent two of the most soluble and widespread constituents of Site-related NAPL and coal tar, were plotted over time to evaluate trends. This exercise was originally performed as part of the RI Report and was included as Appendix O of that report (Appendix A). Those plots have been updated with the recent SRI data, and additional plots have been added for wells not previously included. The updated time-versus-concentration plots that include data from 1998 to 2008 are provided as Appendix BB. Graphs of naphthalene and benzene data included in Appendix BB show decreasing or stable trends in groundwater concentrations for these key constituents throughout all portions of OU1.

Using methods provided in the EPA's Guidance for Data Quality Assessment (EPA, 2000), a further statistical evaluation of time versus concentration data was performed using the Mann-Kendall trend test to confirm whether concentrations of these NAPL and coal tar related constituents are increasing, decreasing, or remaining stable over time. Appendix CC provides the results of the Mann-Kendall analyses that were performed on the same well set for which time-versus-concentration plots were developed. Mann-Kendall tests are nonparametric statistical procedures, meaning that they are suitable for analyzing small data sets (of four or more samples) that involve irregular sampling intervals that do not follow a normal distribution over time. Appendix CC details the Mann-Kendall analyses as well as a summary of the results of these analyses for Site-related constituents, including benzene and naphthalene.

The result of the Mann-Kendall trend testing confirmed that there are no significantly increasing trends for naphthalene and benzene concentrations in groundwater across the Site. At a confidence level of 95 percent, *S* values generated from the Mann-Kendall trend tests suggest that concentration trends are stable or decreasing at 96 percent of the locations evaluated for naphthalene and 76 percent for benzene, at however at a number of monitoring well locations, more data are required to reach a statistically defensible conclusion regarding concentration trends. Decreasing trends were found to be statistically significant for benzene at MW-B (northern portion of the Site) and naphthalene at MW-103DS (southern portion of Site) and MW-114A (central portion of Site). In select cases, certain combinations of *n* and *S* values precluded the determination of a corresponding *p* value, as one does not statistically exist (EPA, 2000). Although, in some cases additional data are needed to confirm the presence of statistically defensible conclusion regarding concentration trends in groundwater, the available dataset provide strong evidence that concentrations of naphthalene and benzene are not increasing along flow paths at OU1.

Updated groundwater concentration plots over time as well as the Mann-Kendall trend testing results provide additional primary lines of evidence that support the statements in the RI Report, that the benzene and naphthalene plumes at the Site are stable and that the extents of NAPL and coal tar-related constituents in groundwater are not expanding beyond the footprint observed today (Figures 4-10 through 4-13). Time versus concentration

plots and Mann-Kendall trend analyses will be updated using the additional data scheduled to be collected in September 2009 as part of the second semiannual groundwater-sampling event. These updates will be provided in the subsequent groundwater-monitoring report.

4.4.2 Discharge to OU2

Flow net diagrams (Figures 3-11 and 3-12) and plan view potentiometric maps (Figure 3-13) show that the bulkhead acts as an impediment to groundwater movement from OU1 to OU2 and in turn controls the pathways for advective flow and constituent transport at the river's edge (Section 3.3.2). Despite this impediment to flow, groundwater eventually moves into OU2 either by flanking the bulkhead to the north or south, or through areas of observed leakage in the bulkhead. Deeper groundwater moves beneath the base of the bulkhead where it is driven upward by strong hydraulic gradients within the nearshore areas immediately downgradient of this structure (Figure 3-11). Discharge of groundwater to the surface water of OU2 via the homogeneous soft organic silt and clay estuarine sediments is generally diffuse. However, areas of preferential groundwater flow consistent with the presence of the bulkhead have been identified through a comprehensive upwelling study using the Trident probe technology (Figure 2-5). Zones of preferential upwelling represent those areas where groundwater from OU1 is most likely discharging to the surface water of the Hudson River.

As stated in Section 5.5 of the RI Report, dissolved phase VOCs and SVOCs in groundwater will be subject to additional absorption and degradation processes as they move from OU1, upward through the sediments at OU2. This will result in lower concentrations in the shallow pore water and ultimately the surface water where they are subject to dilution, volatilization, and photolysis.

The results of shallow pore water and surface water sampling confirm that despite the presence of additional sources within the nearshore sediments at OU2 significant attenuation of NAPL and coal tar constituents in groundwater is occurring downgradient of OU1 prior to the discharge of groundwater to the surface water. Despite the presence of NAPL within the nearshore sediments adjacent to the bulkhead up to depths of approximately 25 feet bss, dissolved concentrations of VOCs and SVOCs are significantly diminished by the time they reach the shallow pore water between 0.5 and 1 feet bss and are present only in nearshore areas (GWZ-1, GWZ-2, and GWZ-5).

The less mobile PAHs, which have an affinity for organic-rich sediments are present at concentrations ranging from below detection limits to 1.94 µg/L (fluoranthene) in the nearshore area beyond the lateral extent of the bulkhead (GWZ-5). The highest concentrations of PAHs in pore water were detected immediately adjacent to the bulkhead at GWZ-1 where NAPL is known to be present (GeoSyntec, 2000; CH2M HILL, 2007d). This was the only location where naphthalene, the most mobile PAH, was detected in the shallow pore water. The detected concentration of this constituent was two orders of magnitude lower than that which has been detected in groundwater immediately upgradient at MW-116A and MW-116B. Naphthalene was not detected in the surface water sample collected at this location.

The more soluble and mobile components of the Site-related NAPL and coal tar consist of aromatic VOCs, primarily the BTEX compounds. The distribution of these constituents is

somewhat similar to that of the PAHs in that they were present in the nearshore shallow pore water only. However, their greater tendency for volatilization as they reach the shallower sediments exposed during low tide has resulted in a smaller footprint within the pore water at OU2 compared to that of the PAHs. Aromatic VOCs were only detected in the shallow pore water along the shoreline at GWZ-1 and GWZ-2, which is indicative of a secondary NAPL source. Unlike the PAHs, aromatic VOCs were not detected in nearshore areas south of bulkhead at GWZ-5.

A reduction in the concentrations of all constituents between the deep ("D") and intermediate ("I") and between the intermediate and shallow ("S") piezometers at PZ-5 also demonstrates that beyond the zones of shallow NAPL sources in the sediments adjacent to the bulkhead, significant attenuation is occurring as pore water moves up into the shallower zones. This same effect is observed beyond the northern and southern extents of the bulkhead at the PZ-1 and PZ-4 clusters, respectively. The inverse is observed adjacent to the bulkhead at piezometer clusters PZ-2 and PZ-3 where the presence of the NAPL in the shallower sediments has resulted in higher concentrations in the pore water 5 feet bss than in the deeper pore water at 25 feet bss. The flow net sections L-L' and M-M' in Figure 3-12 show that the D piezometers at each of these clusters are downgradient of the deeper groundwater at OU1, which has been documented to be minimally impacted by upland NAPL sources.

Pore water concentrations in the samples collected from approximately 5 feet bss at the S piezometers also attenuates significantly before reaching the shallow pore water. These effects are evidenced in the data from the shallow pore water and surface water samples collected at GWZ-1 and GWZ-5, which were located adjacent to piezometer clusters PZ-2 and PZ-4, respectively. Similarly, additional attenuation continues to occur as groundwater moves from the shallow pore water to the surface water. Additional dilution, volatilization, and photolysis results in further reductions of VOC and SVOC concentrations as the pore water discharges at the sediment surface. Results of the surface water samples collected at groundwater upwelling zones shows the presence of only low levels of PAHs just along the shoreline at GWZ-1 and GWZ-5 (Figure 4-14). VOCs in surface water are even less widespread than in shallow pore water, with the only detections of aromatic hydrocarbons being immediately adjacent to the bulkhead at GWZ-1.

The SRI has been successful in evaluating the fate and transport of NAPL and coal tar constituents at the OU1-OU2 interface. The area affected by potential discharge of site-related dissolved phase constituents in groundwater to shallow pore water and surface water is limited to nearshore areas adjacent to and on either side of the wooden bulkhead.

SECTION 5

Inorganic Constituents

Data collected as part of the SRI have been successful in determining the nature and extent and fate and transport of metals in soil and groundwater at OU1. The data and evaluations presented in this section, in combination with those provided in the RI Report, directly address the relevant components of SRI Objectives 1, 6, 7 and 8.

The presence of inorganic constituents in soil and groundwater within the footprint of OU1 is primarily the result of two distinct sources unrelated to the former coal tar-processing and oil-recycling operations associated with the Quanta Resources Superfund Site:

- Fill material – composed partially of black slag, cinders, and coal ash – present across all the properties
- Remnants of buried pyrite ore associated with operations of the former acid plant that existed at the former Celotex property and extended onto the northwestern portions of the Quanta property
- A separate and localized area of pyritic waste within the fill at in the northern portion of the former Lever Brothers property

To a lesser extent, these constituents' presence at OU1 and adjacent properties may be attributable to the rail lines that once ran throughout this area.

Although these sources are unrelated to the former operations associated with the former coal tar-processing and oil-recycling operations associated with the Quanta Resources Superfund Site the extent of constituents within the Site boundaries requires characterization so that these constituents can be addressed appropriately during remedial efforts.

Several areas were identified in the RI Report as requiring additional information to complete the characterization of inorganic constituents in soil and groundwater prior to completion of the RI process for the Site. Furthermore, the delineation of NAPL and coal tar to the southwest at Blocks 93 Central and South necessitated further characterization of soil and groundwater in these areas with respect to inorganic constituents to identify and sufficiently characterize any potential risks to human health. In summary, the following objectives for metals constituents were identified and presented in detail in the approved SRI Work Plan:

- The nature and extent of metals throughout Blocks 93 South and Central and west of Block 93 North (at Block 94) and the former Celotex properties (within the intersection of Gorge and River Roads) (SRI Objective 1)
- Stability of arsenic in groundwater at OU1 (SRI Objective 6)
- Distribution and mobility of arsenic in groundwater within and downgradient of suspected source zones (SRI Objective 7)

- Groundwater flow paths and distribution and fate and transport of arsenic across the groundwater-surface water transition zone(s) between OU1 and OU2 (SRI Objective 8)

This section updates the presentation on the nature and extent of metals in soil and groundwater in the RI Report and supplements the discussions in the RI Report on the fate and transport of arsenic in groundwater relative to the objectives outlined above. Comprehensive discussions in the RI Report on the suspected and known sources of metals contamination, the composition and characteristics of these sources, and the fate and transport of all inorganic constituents in soil and groundwater remain relevant and applicable unless otherwise noted herein.

5.1 Nature and Extent in Soil

Upon submittal of the RI Report in August 2008, additional delineation of arsenic, and to a lesser extent iron and lead, was required for areas west of the current Quanta property, near Blocks 93 North, Central, and South and Block 94, and within the intersection of Gorge and River Roads. A component of Objective 1 of the SRI Work Plan was to determine the nature and extent of arsenic in soil in these areas. Based on the results of additional soil sampling performed during the SRI these remaining data gaps have been addressed.

To evaluate and discuss the nature and extent of constituents in soil samples collected at the Site as part of the SRI, laboratory analytical results for all constituents were screened against the following applicable soil screening criteria:

- New Jersey Residential Soil Cleanup Criteria (NJDEP, 2009)
- New Jersey Nonresidential Soil Cleanup Criteria (NJDEP, 2009)
- EPA Regional Industrial Soil Screening Levels for Chemical Contaminants at Superfund Sites (EPA, 2008b)
- EPA Regional Residential Soil Screening Levels for Chemical Contaminants at Superfund Sites (EPA, 2008c)

As mentioned in Section 4.2, the 2004 EPA Region 9 Preliminary Remediation Goals were replaced in September 2008 by the EPA Regional Soil Screening Levels for Chemical Contaminants at Superfund Sites. To maintain consistency with the RI Report, a separate screening of constituents in soil samples collected during the SRI was conducted against the same criteria used during the RI to determine a list of constituents of potential concern (COPCs) and ultimately address all the appropriate constituents as part of the updates to the human health risk characterization. The results of this effort as are discussed in detail in Section 7.

Comparisons of concentrations of inorganic constituents in soil relative to the screening criteria listed above are summarized in Table 4-1. Table 4-2 lists the constituents exceeding EPA or state screening levels in soil for inorganics and summarizes the screening results for each SRI soil sample collected and includes compounds present because of historical Site activities associated with the former acid plant operations as well as non-Site-related sources associated with fill and other background conditions in the area. Laboratory analytical

results for all SRI soil samples evaluated in this report are tabulated in Appendices E through K. The analytical laboratory reports for the soil samples are in Appendix S.

Inorganics soil data collected as part of the SRI were consistent with RI data with respect to concentration ranges and distribution in soil. Detections of arsenic and other metals above their lowest applicable screening criteria were observed sporadically throughout the shallow soil beyond the extents of the former acid plant. In general the presence and concentrations of these metals as well as the percentages of samples in which they exceeded screening criteria during the SRI were similar to those for the RI data (Table 4-2). With the exception of a localized area in the northern portion of the former Lever Brothers property, the presence of metals at OU1 outside the area of the former acid plant operations can be attributed to the fill that is ubiquitous at the Site and all adjacent properties.

As was the case in the RI, the three metals exceeding screening criteria most frequently in SRI soil samples were arsenic, iron, and lead. The distributions of arsenic and iron exceedances in soil are similar; however, elevated concentrations of lead are more widespread, because of its greater prevalence throughout the fill. Figures representing the distribution of arsenic and lead in both unsaturated (generally less than 4 feet bgs) and saturated (generally greater than 4 feet bgs) soil have been updated and included as part of this report as Figures 5-1 through 5-4.

Consistent with the findings of the RI, arsenic was observed not only within areas of former acid plant operations but across all properties because of the presence of fill material. Of the 94 SRI soil samples analyzed for arsenic during the SRI, 98 percent exceeded the lowest applicable screening criterion for this constituent (0.39 mg/kg). This exceedance rate is consistent with the RI soil data, which had a 95 percent exceedance rate for arsenic across the 665 soil samples evaluated. Because of the ubiquity of fill material the RI Report data have been contoured to 100 mg/kg. This was done to delineate particular areas where concentrations are above what is typically observed throughout the area, either because of the presence of hotspots in the heterogeneous fill or because of former industrial operations related to sulfuric acid production. In addition, a contour interval of 336 mg/kg which represents arsenic concentrations in soil that may constitute a Principle Threat Waste was also included on Figures 5-1 and 5-2. This threshold value was calculated as part of the draft Preliminary Feasibility Study Report (CH2M HILL, 2009) and is intended to show relatively toxic source material that may represent a direct contact risk (e.g., greater than 10^{-3} excess lifetime cancer risk or ELCR) under certain conditions. The extent of these concentrations in soil throughout OU1 is also illustrated in the various cross sections in Figures 3-1 through 3-7.

The distribution of arsenic as well as lead and other metals exceeding soil screening criteria is discussed in the following subsections relative to those areas where data gaps were identified. Comprehensive discussions on the nature and extent of all inorganic constituents in soil provided in Section 4.3.4 in the RI Report remain relevant and applicable unless otherwise noted herein. Additional analysis of select soil samples involving sequential extractions (SEP) were performed as part of a separate evaluation of arsenic mobility and attenuation within and downgradient of source areas and are presented and in Section 5.3.

5.1.1 Block 93 (North, South, and Central) and Block 94

The SRI has successfully characterized soil conditions with respect to metals west of River Road at Blocks 93 North, Central, and South. Figures 5-1 through 5-4 present revised isoconcentration contours for arsenic and lead, respectively, for unsaturated soil (less than 4 feet bgs) and saturated soil (greater than 4 feet bgs). These figures include all available soil data.

Arsenic

During the SRI, there were no observations of reddish-purple soil within borings completed throughout the western portion of the Site (Blocks 93 North, Central, and South and Block 94). This supports the conclusion that the pyritic waste material within the footprint of the former acid plant is not present throughout the western portion of the Site. Concentrations of arsenic in soil in these areas are consistent with the coal, coal ash, and cinders that make up the fill material and were observed during SRI and RI activities. Data supporting this conclusion are discussed in Section 5.3.

Soil concentrations exceeded the lowest applicable soil screening criterion for arsenic (0.39 mg/kg – EPA Regional Residential Screening Level) in both unsaturated and saturated soil at all SRI locations across these properties. Consistent with the RI, detections of arsenic in SRI soil samples from this area exceeding the Principal Threat Waste threshold of 336 mg/kg were limited to shallow unsaturated soils in the eastern portion of Block 93 Central near the former rail lines. Additional sporadic detections of arsenic in the unsaturated fill above 100 mg/kg were detected at one location on Block 93 South (TL10.5-10.5) and one location at Block 94 (MW-128). All saturated soil samples collected at these properties during the SRI were below 100 mg/kg.

Other Inorganics

Other inorganic constituents detected in soil samples above screening criteria during the SRI within the western portions of the Site (Blocks 93 North, Central, and South and Block 94) included iron, lead, vanadium, and mercury. The applicable soil screening criteria for these constituents are summarized in Table 4-1. Like arsenic, each of these metals is present as a component of the anthropogenic fill. Iron, lead, and vanadium were detected in all 53 samples collected from across these properties in both the saturated and unsaturated fill deposits, and mercury was detected here in all but four samples. Mercury and vanadium each exceeded the lowest applicable screening criterion in three samples and iron in one. Consistent with the RI results, the exceedance rate for lead in soil was slightly higher, with nine samples exceeding the lowest applicable screening criterion of 400 mg/kg. The maximum concentration for each of these metals in soil samples collected during the SRI is well within the range of concentrations observed across all properties in the area during the RI, and with the exception of lead, the distribution of screening criteria exceedances are sporadic and discontinuous.

The distributions of lead in both unsaturated and saturated soils are depicted in Figures 5-3 and 5-4, respectively. The extent of lead concentrations in the fill that exceed screening criteria at Blocks 93 North and Central, shown in Figures 4-21 and 4-22 of the RI Report (Appendix A), have been delineated in both saturated and unsaturated soil west, north, and south and do not extend beyond the edges of these properties.

5.1.2 Gorge Road–River Road Intersection

The SRI has successfully characterized the extent of arsenic and other metals related to the former acid plant as well as the fill northwest of the Quanta property, within the intersection of Gorge and River Roads. Additional soil sampling was performed within the intersection and northwest of it, at Block 92.01. Figures 5-1 through 5-4 present revised isoconcentration contours for arsenic and lead, respectively, for unsaturated soil (less than 4 feet bgs) and saturated soil (greater than 4 feet bgs). These figures include all available soil data including those collected most recently as part of the SRI.

Arsenic

During the completion of soil borings within and at the periphery of the intersection of Gorge and River Roads, reddish-purple soils associated with operations at the former acid plant (HCAA) were observed at two locations in fill deposits deeper than 4 feet bgs at soil borings. These borings were drilled immediately adjacent to the northwest corner of the Quanta property (SB-49, between 3.5 and 15 feet bgs) and in the southwest corner of the former Celotex property (SB-51, between 7 and 7.3 feet bgs; SB-54, between 9.5 and 12 feet bgs). The distribution and thicknesses of this material is generally consistent with what was illustrated in Figure 4-5 of the RI Report (Appendix A). Thus, the western extents of reddish-purple soils corresponding to the HCAA have been defined.

Consistent with background soil conditions in the area soil concentrations exceeded the lowest applicable soil screening criterion for arsenic (0.39 mg/kg—EPA Regional Residential Screening Level) in both unsaturated and saturated soil at all SRI locations within and adjacent to the intersection of Gorge and River Roads. Generally, RI and SRI soil samples exceeding the Principal Threat Waste threshold of 336 mg/kg were limited to the deeper saturated soils along the eastern edge of River Road that are associated with the HCAA. The one exception to this was a thin zone of soil within the saturated fill between 11.3 and 12 feet bgs at SB-58 that represents an isolated area of elevated arsenic concentrations (2,020 mg/kg) in excess of the Principal Threat Waste threshold. Samples collected above and below this interval and to the southwest and northeast document that these conditions do not extend in these directions. This isolated hot spot appears to be the result of the heterogeneity of the anthropogenic fill, which has resulted in similar hotspots throughout all the properties in the area, including Block 94 North and the former Lever Brothers property. The characterization of soil directly west of this location was not possible due to the presence of the Waterford Towers building; however, it is likely that construction here resulted in the removal and replacement of shallow, organic-rich fill in favor of more suitable materials. Outside of these areas, no other saturated or unsaturated SRI soil samples collected near the intersection of Gorge and River Roads contain arsenic at a concentration greater than 100 mg/kg.

Other Inorganics

Other inorganic constituents detected in soil samples above screening criteria during the SRI within the intersection of Gorge and River Roads and to the west, at Block 92.01, include iron, lead, vanadium, mercury, thallium, antimony, and cobalt. The applicable soil screening criteria for these constituents are summarized in Table 4-1. With the exception of vanadium, the SRI soil samples with the highest concentrations of these metals collected within this

portion of the Site corresponded to locations where higher concentrations of arsenic were observed (SB-49, 4 to 5 feet bgs; SB-58, 11.3 to 12 feet bgs). These metals were detected only above their lowest applicable screening criteria in the deeper saturated soils (greater than 4 feet bgs) in this area. The sample collected at SB-49 between 4 and 5 feet bgs is associated with the HCAA.

The soil sample collected at SB-49 between 4 and 5 feet contained the highest concentration of mercury in soil (137 mg/kg) encountered during the SRI. As mentioned previously, this sample represents an interval of “dusky red” soil at the periphery of the reddish-purple pyritic material that corresponds to the HCAA. This result supports the conclusion of the RI Report: that this constituent was consistently present at concentrations an order of magnitude higher in the area of reddish-purple soils than in other areas of OU1 affected by the presence of fill.

Vanadium was detected above its lowest screening criterion at two locations, with the highest concentration (84.4 mg/kg) in soil at MW-126 from 11 to 11.5 feet bgs. Concentrations in soil samples collected during the SRI beyond the area of reddish-purple soils associated with the HCAA are within the range of concentrations observed in anthropogenic fill across all properties. With the exception of shallower fill deposits, which have been reworked and replaced with cleaner material as part of construction activities, frequencies at which soil samples collected from these intervals exceed their lowest applicable soil screening criteria are also consistent with the RI data collected from other portions of the Site. As stated previously, the interval of deeper fill material at SB-58 having elevated metal concentrations including arsenic and lead is consistent with other hotspots observed sporadically within the anthropogenic fill across all the properties in the area.

5.2 Nature and Extent in Groundwater

As with the need to further delineate inorganic constituents in soil, the need to delineate arsenic and to a lesser extent iron and lead in groundwater was identified at the time the RI Report was submitted. Specific areas at which further data were needed included to the west of current Quanta property, near Blocks 93 North, Central, and South; Block 94; and within the intersection of Gorge and River Roads. A component of Objective 1 of the SRI Work Plan was to determine the nature and extent of arsenic in groundwater in these areas. Part of Objective 7 was to determine the distribution of arsenic in groundwater within and downgradient of suspected source areas at OU1. In addition, a portion of Objective 8 was related to the distribution of arsenic across the groundwater-surface water interface along the shoreline. Based on the results of well installations and additional groundwater sampling performed during the SRI, these remaining data gaps have been addressed.

To evaluate and discuss the nature and extent of constituents in groundwater at the Site as part of the SRI, laboratory analytical results for all constituents were screened against the following applicable groundwater screening criteria:

- Higher of the Groundwater Quality Criterion and the Practical Quantitation Limit presented for each constituent in Appendix Table 1 of Chapter 7:9C of the NJAC. For those constituents that do not currently have a GWQS, an interim generic groundwater quality criterion was used according to NJAC Section 7:9C-1.7 (C)(6).

- EPA Regional Screening Levels (RSLs) for Tap Water (EPA, 2009b).
- EPA Maximum Contaminant Levels (MCLs) from Primary Drinking Water Regulations (EPA, 2002).

As part of the RI Report, groundwater data were screened against the 2004 EPA Region 9 PRGs for tap water. However, in September 2008 the Region 9 PRGs were replaced by the EPA RSLs for Chemical Contaminants at Superfund Sites. To maintain consistency with the RI Report, a separate screening of constituents in groundwater samples collected during the SRI was conducted against the same criteria used during the RI to determine a list of COPCs and ultimately address all the appropriate constituents as part of the updates to the human health risk characterization. The results of this effort as are discussed in detail in Section 7.

As stated in Section 4.3, the first of two semiannual groundwater-sampling events as part of SRI activities has been completed. A second event is scheduled to be completed in September 2009, the data from which will be provided under separate cover. All SRI groundwater data from the first round were compared to the lowest applicable screening criteria listed above and summarized in Table 4-3.

In addition to the dissolved phase arsenic, lead, and iron that were identified during the RI, inorganic constituents exceeding their lowest applicable screening criteria for groundwater also include aluminum, antimony, arsenic, beryllium, cadmium, cobalt, manganese, mercury, nickel, selenium, sodium, thallium, vanadium, zinc, chloride, and sulfate. These additional inorganics were not identified as constituents that exceeded EPA or state screening levels during the RI (Table 4-7 of the RI Report) because the SRI represents the first time that groundwater samples collected at the Site were analyzed for these parameters. Like arsenic, iron and lead most these constituents are present in groundwater either as the result of sources of pyritic material or the presence of heterogeneous fill containing coal, coal ash, and slag across the area. Exceptions to this include sodium and chloride which are present because of the saline conditions associated with the Hudson River as well as the use of road salt in the area. Laboratory analytical results for all SRI groundwater samples evaluated in this report are tabulated in Appendices M through R. Copies of the analytical laboratory reports for groundwater samples are in Appendix S.

SRI groundwater sampling included the collection and analysis of filtered and unfiltered metals samples to determine what fraction of these constituents (including arsenic, lead, and iron) is potentially mobile (dissolved concentration) versus that which is essentially immobile and associated with particulate matter suspended within the extracted sample (total concentration). Prior to the SRI, only select samples collected from OU1 had been analyzed for dissolved arsenic, iron, and manganese.

In addition, samples were collected for other inorganic parameters (e.g. sulfate and total phosphorus) to help discern various arsenic sources and to develop an improved understanding of the geochemical dynamic affecting arsenic. Additional specialty chemical analyses of groundwater from select monitoring wells were conducted during the first SRI semiannual sampling event, including arsenic III and V speciation samples. These data were collected as part of a specific evaluation of arsenic mobility and attenuation within and downgradient of source areas. These data are presented and discussed separately in Section 5.3.

Figures representing the distribution of dissolved arsenic, iron, and lead in groundwater have been updated and included as part of this report as Figures 5-5, 5-6, and 5-7. Although all groundwater data for these constituents were evaluated against the lowest applicable criteria, in the case of lead and arsenic the EPA RSLs for Tap Water represented the lowest screening criteria. This criterion, however, was below the achievable laboratory detection limits. Because of this, as well as the ubiquity of fill material resulting in low level concentrations of arsenic across the area, data for these constituents have been contoured to the NJGWQS, which represent the next lowest applicable criteria (3 µg/L for arsenic, 5 µg/L for lead). This approach is consistent with practices used during the RI. In addition to arsenic, lead, and iron, figures displaying the extents of sulfate and total phosphorus in groundwater are provided as Figures 5-8 and 5-9, respectively.

The distribution of the dissolved concentrations of inorganics in groundwater exceeding screening criteria will be discussed in the following subsections relative to the areas where data gaps were identified. Comprehensive discussions on the nature and extent of all inorganic constituents in groundwater, provided in Section 4.4.4 in the RI Report, remain relevant and applicable unless otherwise noted herein.

5.2.1 OU1

The SRI has been successful in completing the characterization of groundwater conditions within OU1, particularly in areas stated above, including Blocks 93 North, Central, and South; Block 94; and within the intersection of Gorge and River Roads. Groundwater geochemistry plays a key role in the distribution of inorganic constituents in groundwater, particularly arsenic. This relationship is detailed in Section 5 the RI Report (Appendix A), and additional discussion in Section 5.3 of this report supplements and updates that discussion using additional data collected during the SRI. In addition, although the distribution of arsenic was the focus of Objective 1 of the SRI Work Plan, the distribution of other inorganic parameters was also evaluated to better understand the fate and transport of Site-related constituents.

Arsenic

The distribution and range of total arsenic concentrations detected during the SRI is consistent with the RI. Within the extents of OU1 there are four distinct areas of elevated arsenic concentrations extending from the HCAA south and east, as well as other isolated and smaller areas associated with separate source zones farther south at the former Lever Brothers property, to the west at Block 93 North and along the shoreline to the north and south of the wooden bulkhead. Additional areas of elevated arsenic concentrations in soil and groundwater have also been observed beyond the southern extents of OU1 throughout various portions of the former Lever Brothers property as part of separate environmental investigations performed here under separate administrative orders and with oversight from the NJDEP. In general, these conditions are the result of arsenic hotspots associated with the heterogeneous fill material; they are further discussed in Section 5.3.2. Just to the south of OU1, along the shoreline of the former Lever Brothers, one such area is present near monitoring wells MW-51A and MW-109A. Data here have been contoured to illustrate the physical separation of arsenic in groundwater here from that associated with arsenic sources further inland to the northwest which are present within the extents of OU1 (Figure

5-5). The sources of all elevated arsenic concentrations within the extents of OU1 are each discussed in detail in Section 5.3.2.

Of the 48 groundwater samples analyzed for total arsenic during the first semi-annual SRI groundwater sampling event, 79.2 percent were characterized by arsenic concentrations that exceeded the lowest applicable screening criterion for this constituent (EPA RSL for Tap Water – 0.045 µg/L). Groundwater sampling results for the RI exceeded the same screening criterion in 95.8 percent of the samples. The slightly lower exceedance rate observed during the SRI is a result of the expansion of sampling activities to the south and west at Blocks 93 Central and South and Block 94, which represent “cleaner” areas outside localized sources in the heterogeneous fill that were identified during the RI at Block 93 North.

Near Block 93, concentrations of arsenic above the NJGWQS that have resulted from the presence of fill and are present as far south as Block 93 South adjacent to the Medical Arts Building on Block 93 South at MW-123. Where additional data were required to delineate the extent of arsenic groundwater data to the west and north of Block 93 arsenic concentrations were non-detect in samples collected from MW-128 and MW-129 on Block 94 and slightly above the NJGWQS (3 µg/L) at MW-125 at a concentration of 3.5 µg/L. The extent of elevated arsenic concentrations in groundwater observed in samples collected from MW-111 series wells has been delineated in all directions. Based on the sampling results from monitoring wells 3Y-MW2 and MW-126 to the east of this area, dissolved arsenic at the MW-111 is not associated with the HCAA located farther east across the intersection of Gorge and River Roads.

The highest concentrations of arsenic observed in groundwater remain within the HCAA. As evidenced in the reduced concentrations in the shallower (“A”) wells at MW-112A, MW-114A, MW-103A, and MW-130A these impacts do not extend beyond the central portion of the Quanta property to the south. In the deeper unconfined groundwater (native sand above the silty clay confining unit) where groundwater velocities are relatively higher, elevated concentrations of arsenic associated with the HCAA extend farther south, where concentrations of soluble arsenic and other related constituents such as iron and sulfate are reinvigorated due to a separate but smaller source in the northern portion of the former Lever Brothers property. Concentrations decline rapidly from here to the east, but increase again near the shoreline in the northern portion of the Lever Brothers property because of sources of arsenic in the fill and geochemical conditions enhancing arsenic solubility.

To the east of the HCAA, elevated arsenic concentrations within the thin saturated deposits above the bedrock high remain elevated into the parking lot area at the southern portion of the former Celotex property. These concentrations decline rapidly downgradient of MW-133. Consistent with the RI, approximately 160 feet further downgradient a separate area of elevated concentrations of arsenic in groundwater was observed near the shoreline in the southern portion of the former Celotex property because of sources of arsenic in the fill and geochemical conditions enhancing arsenic solubility. Data from a newly installed well adjacent the shoreline (MW-134) confirms that arsenic concentrations are increasing toward the river in this localized area.

Concentration gradients observed along key groundwater flow paths confirm that the extent of groundwater impacts associated with the HCAA do not extend as far as OU2 and that other smaller sources of arsenic are affecting groundwater conditions along these transects.

Further evaluations of these data are presented in context of the fate and transport discussions for arsenic presented in Section 5.3.

Other Inorganics

The presence of the pyritic material as well as sources in the heterogeneous fill deposits have resulted in the presence of other inorganic constituents in groundwater above screening criteria. Pyrite is an iron sulfide mineral (FeS_2) and its oxidation has resulted in elevated concentrations of its main components; iron (Figure 5-6) and sulfate (Figure 5-8). Impurities or other minerals associated with pyrite include arsenic, antimony, beryllium, cadmium, cobalt, lead, mercury, nickel, selenium, thallium, vanadium, and zinc; some of which are also present within the fill deposits. Acidic groundwater near oxidizing pyrite sources has also resulted in the localized dissolution of aluminum and several other metals listed above that are associated with the native sand deposits and/or the slag-rich fill. These secondary metals have a distribution similar to that of arsenic and sulfate but are much less prevalent and are well within the footprint of the arsenic plume. The dissolved sulfate concentrations in groundwater are directly attributable to the pyrite dissolution; however, the presence of iron in groundwater, albeit at lower concentrations, also results from its presence within the fill deposits. Manganese, like iron is also widespread in groundwater because of its presence within the fill, but like most metals is generally found at its highest concentrations near pyritic source areas.

Dissolved concentrations of lead from groundwater samples collected during the SRI confirmed that prior RI data for total lead did not accurately reflect the concentrations of soluble and potentially mobile fractions of this constituent. A comparison of Figure 5-7, which shows isoconcentration contours for dissolved lead, with Figure 4-37 of the RI Report (Appendix A) shows that dissolved lead concentrations are not nearly as widespread as previously suggested by the RI data and are contained to a smaller area within the footprint of the HCAA.

Exceedances of chloride and sodium were also observed to be widespread across groundwater throughout OU1 and beyond; these are the result of background conditions associated with the Site's proximity to the saline Hudson River as well as the application of road salt throughout the area. The pattern of chloride and sodium concentrations in groundwater is very different than that of the other inorganics with the highest concentrations at OU1 located in wells adjacent to the shoreline.

5.2.2 Nearshore Groundwater and Pore Water

As a component of SRI Objective 8 the characterization of arsenic in groundwater and pore water along the shoreline interface with OU2 has been completed. Elevated arsenic concentrations in groundwater along the shoreline at OU1 are sporadic and are unrelated to the pyritic sources, as evidenced by the dramatically lower sulfate and iron concentrations in this area that are signatures of this material. In addition, in the absence of the acid generating conditions associated with the pyrite oxidation, metals other than arsenic that are associated with fill are generally not found in groundwater along the shoreline above screening criteria with the exception of manganese. As mentioned previously, chloride and sodium are found at elevated levels in groundwater adjacent to the Hudson River due to the salinity of this adjacent water body.

The significance of all inorganic constituents as measured in the shallow pore water and surface water at OU2 including arsenic and the potential risk that they pose to potential receptors within OU2 is being evaluated as part of a BERA being performed for OU2. For the purpose of the SRI a preliminary screening of shallow pore water and surface water results against the following criteria was performed:

- Toxicological Benchmarks for Screening Potential Contaminants of Concern from the ORNL Environmental Restoration Program (Suter and Tsao, 1996)
- NOAA Screening Quick Reference Tables (Buchman, 2008)
- New Jersey Surface Water Quality Standards, NJAC Section 7:9B
- New York Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations from Technical and Operational Guidance Series 1.1.1
- EPA Region III Freshwater Screening Benchmarks (EPA, 2009c)
- EPA Region III Marine Screening Benchmarks (EPA, 2008b)

A summary of these comparisons can be found in Table 4-5. As mentioned previously, the comparison of pore water results, and to a lesser extent surface water, results against the screening criteria outlined above is an extremely conservative means by which to evaluate these data for the purpose of the SRI Report.

Arsenic

The highest concentrations of arsenic in groundwater adjacent to OU2 were detected in the groundwater sample collected from the newly installed monitoring well MW-134 to the north of the wooden bulkhead; the dissolved concentration of arsenic at this location was 4,320 µg/L. One additional area of elevated arsenic concentrations adjacent to the shoreline was detected outside the extent of Quanta-related constituents in soil and groundwater near monitoring well MW-109A to the south of the bulkhead at the former Lever Brothers property. Dissolved arsenic is present in this area at concentrations of up to 127 µg/L (MW-30) and total arsenic concentrations have been found as high as 1,860 µg/L at MW-109A. Samples collected from each of these areas along the shoreline represent groundwater within the fill deposits. Fill material along the shoreline area to the south of the bulkhead at the former Lever Brothers property has been characterized as containing an abundance of vesicular glassy slag material with concentrations of arsenic above the screening criteria, as well as pieces of hard asphaltic material intermixed within the eroding fills present along with gravel and cobbles on the adjacent shoreline. Observations of wood and brick within the fill were noted in the boring log for MW-134. Behind and at the immediate flanks of the bulkhead, where NAPL Zone NZ-2 is present, dissolved arsenic concentrations are all below the laboratory method detection limits and total arsenic has only been detected during the RI and SRI groundwater sampling at a concentration only as high as 12.2 µg/L (MW-120B).

Detectable concentrations of arsenic within the pore water were only observed at the nearshore groundwater upwelling zones identified at OU2 during the SRI (GWZ-1, -2, and -5). Arsenic was not detected in pore water samples collected from upwelling zones farther from the shoreline (GWZ-3, and -4) or in the surface water samples collected from any of the upwelling zones at OU2. The highest concentrations of arsenic in shallow pore water were

observed in nearshore areas next to the former Lever Brothers and former Celotex properties, with dissolved concentrations of 46.2 µg/L (GWZ-5) and 33.8 µg/L (GWZ-2), respectively. The concentration of dissolved arsenic at GWZ-5 represents the only pore water or surface water samples collected at OU2 as part of the SRI that exceeded the surface water screening criteria referenced above for this constituent (Table 4-5). With the exception of GWZ-2 the concentrations of soluble arsenic in nearshore pore water were higher than those found in the nearest upgradient monitoring wells. OU2 investigations indicate that higher concentrations of arsenic in the shallow sediment are present along the shoreline in the northern portion of the former Lever Brothers property (CH2M HILL, 2007d). This is believed to be a result of the eroding shoreline in this area that has an abundance of glassy slag that has been found to contain arsenic. The higher pore water concentration at GWZ-5 relative to those found elsewhere at OU2 is likely a result of this upland source to the sediments. North of the bulkhead at GWZ-2 concentrations of dissolved arsenic (33.8 µg/L) in the shallow pore water were substantially lower (two orders of magnitude) than the concentrations observed in nearshore upland groundwater monitoring well samples collected from MW-134 (4,320 µg/L).

In shallow nearshore pore water at GWZ-1, 15.3 µg/L of dissolved arsenic was detected; dissolved arsenic is not been observed in the upgradient groundwater here behind the bulkhead. Similarly, deeper pore water samples collected slightly south of this location directly in front of the bulkhead from depths of approximately 5, 15 and 25 feet bss at the PZ-3 piezometer cluster also had higher dissolved concentrations (up to 340 µg/L) than the upgradient groundwater. At GWZ-5 still farther to the south, a similar concentration gradient is observed between the unimpacted groundwater at OU1 and the shallow and deeper pore water at OU2. With the exception of the one nearshore location to the north of the bulkhead (GWZ-2) data indicate that the presence and distribution of dissolved arsenic at OU2 is not solely the result of advective transport in groundwater from OU1 and that it is controlled, at least in part by its presence within the sediments as well as the local redox conditions. The observed redox conditions in nearshore areas and how they relate to the presence and fate and transport of arsenic in both upgradient in groundwater at OU1 as well as in the pore water of the sediments at OU2 is discussed in Section 5.3.

Other Inorganics

A number of other inorganic constituents were detected in shallow pore water and surface water samples collected during the SRI (Appendix P). These detections are the result of the presence of these constituents within the sediments and surface water associated with the Hudson River. Of note was a single detection of dissolved lead within the pore water GWZ-5 (17 µg/L), as well as two detections of dissolved iron at GWZ-1 and GWZ-5 at concentrations of 2,820 and 1,730 µg/L, respectively. These detections all represented exceedances of the surface water screening criteria listed above. As shown on Figure 5-7, dissolved lead is not present in nearshore upland groundwater anywhere at the Site. Iron is present as a component of the fill and native soils at OU1, but is generally observed at lower dissolved concentrations in groundwater than the levels observed in the shallow pore water as well as deeper pore water samples collected from select OU2 piezometers. Like arsenic, the distribution of these constituents in the pore water at OU2 is controlled by their presence within the sediments and the redox conditions within the sediments at OU2.

5.3 Fate and Transport of Arsenic in Groundwater

The factors affecting the migration of arsenic in both soil and groundwater are presented and discussed in detail in Sections 5.5 and 5.5.3 of the RI Report (Appendix A). The presentation and discussions of additional Site-specific data collected during the SRI are aimed at addressing the components of SRI Objectives 6, 7 and 8 that relate to arsenic fate and transport in groundwater. The specific objectives of these SRI Objectives that relate to arsenic fate and transport are as follows:

- **Objective 6.** Collect data to confirm stability of arsenic in groundwater at OU1.
- **Objective 7.** Confirm distribution and mobility of arsenic in groundwater within and downgradient of suspected source zones at OU1.
- **Objective 8.** Characterize groundwater flow paths and distribution and fate and transport of arsenic across the groundwater–surface water transition zone(s) between OU1 and OU2

Work performed during the SRI has resulted in further refinement of arsenic source areas. Specialty soil analyses and further characterization of the geochemical context have resulted in lines of evidence that support a detailed understanding of the mechanisms affecting the behavior of arsenic at the Site. The presence of soluble arsenic in groundwater at and downgradient of these source areas has been characterized throughout OU1 and within the shallow pore water and surface water at groundwater upwelling zones within OU2. Arsenic attenuation was evaluated along the primary groundwater flow pathways at the Site. The data support the conclusion that attenuation of this constituent in groundwater is occurring and that the footprint of the soluble arsenic in groundwater at the Site is generally stable and not expanding.

Groundwater upwelling zones were identified in nearshore areas, adjacent to and north and south of the bulkhead, and in other diffuse areas farther from the shoreline. Soluble arsenic was found only in nearshore pore water samples. Soluble arsenic within the nearshore pore water is not the result of ongoing advective transport from OU1 with the exception of perhaps a small area of groundwater discharge identified at GWZ-2 at the northern end of the bulkhead. Here soluble arsenic concentrations in shallow pore water are up to 2-orders of magnitude lower than those in the adjacent upland groundwater. The results from surface water samples collected at all nearshore areas show an absence of arsenic. Furthermore, there is no measurable discharge of dissolved phase arsenic to the surface water at groundwater upwelling zones identified farther from the shoreline, which is discussed in Section 5.3.6.

The following subsections present the data and evaluations that address the specific data gaps addressed by SRI Objectives 6, 7, and 8. The following sections provide additional detail with respect to the Site-specific factors controlling arsenic solubility, define the arsenic source areas, and describe the geochemical zones within the Site which control arsenic fate and transport. Arsenic attenuation along the five primary groundwater flow pathways, the stability of the arsenic plume and the potential impacts to OU2 are then detailed in the context of the aforementioned factors.

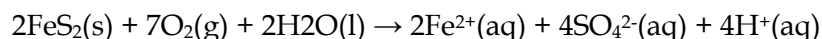
5.3.1 Solubility

The solubility of arsenic is controlled by a combination of variables, including pH, redox conditions (as measured by Eh), iron oxide state and content, cation exchange capacity, major ion chemistry, and organic content of the soil. Redox conditions at the Site are controlled by the Site-wide sources of organics, including native peat as well as NAPL. The combination of Eh and pH conditions dictates the reductive dissolution of redox-sensitive iron oxyhydroxides that serve as key adsorption sites for arsenic. If present, other ionic constituents such as orthophosphates may compete with arsenic for these adsorption sites, causing arsenic to remain in solution. In addition, the reduced conditions resulting from the presence of dissolved phase organics can affect the affinity of arsenic to adsorb by creating a greater abundance of the reduced and more weakly charged arsenite species (As^{+3}) versus arsenate (As^{+5}), thus promoting greater mobility in groundwater.

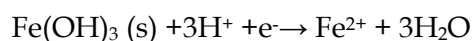
Concentrations of arsenic, iron, sulfate, and total phosphorus in groundwater samples collected from across the Site have been plotted and contoured in Figures 5-5, 5-6, 5-8, and 5-9, respectively. In addition, the average of Eh and pH values measured at each well across all RI and SRI groundwater-sampling events are plotted and contoured in Figures 5-10 through 5-13 for both shallow unconfined groundwater (water table) and deeper unconfined groundwater (above the surface of the silty-clay aquitard).

The key mechanisms and factors resulting in the presence of soluble arsenic at OU1 include the following:

- Leaching of Acid Wastes.** As groundwater moves through the soils where the iron sulfide mineral pyrite is present, it is oxidized, resulting in the release of ferric iron (Fe^{2+}) and sulfate as well as impurities in the pyrite and associated minerals, which include arsenic and lead. As a result, groundwater in areas containing pyritic waste has an acidic pH and higher Eh (+200 millivolts [mV]), with very high concentrations of iron and sulfate. This process is expressed in the following general equation:



- Reductive Dissolution.** Where native organics, organic-rich fill, or the presence of NAPL is causing a reducing environment, iron oxyhydroxides are reduced and dissolved, releasing coprecipitated and adsorbed arsenic. Furthermore, the affinity for arsenic to adsorb to iron oxyhydroxides is also affected by this reducing environment; the oxidized +5 form of arsenic (arsenate) is reduced to the +3 form (arsenite). Arsenite has less affinity for adsorption to iron oxyhydroxide than arsenate, enhancing the mobility of arsenic in the reduced groundwater. Groundwater in areas of reductive dissolution has a lower Eh (typically less than 0), a more neutral pH, frequently higher organic carbon and alkalinity, and lower concentrations of iron and sulfate relative to areas of acid waste leaching. This reductive dissolution process for iron is expressed in the following half-cell reaction:



If groundwater reaches sulfate reducing conditions iron will reprecipitate as iron-sulfide minerals and thioarsenic species may form if iron is not abundant (EPA, 2007).

- **Competition with Orthophosphates.** Elevated levels of orthophosphates in Site groundwater, as evidenced in total phosphorus concentrations (Figure 5-9), significantly limits the adsorption/attenuation of arsenic within and downgradient of source areas due to competition with arsenic for adsorption Sites associated with the iron oxyhydroxides. The presence of this inorganic form of phosphorus is generally related to the coal tar because it is a byproduct concentrated within the coal tar during the distillation process. The effect of orthophosphates on arsenic concentrations is illustrated by the strong linear correlation between dissolved arsenic and total phosphorus concentrations illustrated in Figure 5-14. This relationship holds true across the range of observed arsenic concentrations in groundwater at OU1.

5.3.2 Confirmed Source Areas

Roasted or partially roasted pyrite ore within the footprint of the former acid plant in the northwest portion of the Quanta property and the southwest corner of the former Celotex property has resulted in arsenic concentrations in soil generally several orders of magnitude greater than those observed elsewhere at the Site. This area, the HCAA, is the most significant source of arsenic at the Site and is characterized by a distinct geochemical signature that includes lower pH, higher Eh, and elevated levels of arsenic, iron, sulfate, and other metals because of the oxidation of the pyritic material. As shown in Figures 5-1 and 5-2 and discussed in Section 5.1, arsenic is also present in soil throughout the area because of the ubiquitous anthropogenic fill material containing coal, coal ash, wood ash, brick, and glassy slag that was used to raise the topographic elevation adjacent to the Hudson during the mid- to late nineteenth century. The heterogeneity of the fill material and its components has resulted in hotspots of arsenic and other metals, including lead. Whether or not hot spots of arsenic in the fill serve as a source to groundwater depends on the intensity of source term as well as the geochemical setting within which they reside.

Beyond the HCAA are three areas representing localized and isolated sources of arsenic to groundwater that have been identified within the extents of OU1. These additional areas are referred to as arsenic source areas (ASAs) 1, 2, and 3. All ASAs, including the HCAA, have been defined and evaluated as part of the SRI using all available soil data and geochemical data for groundwater. The locations of arsenic source areas are illustrated in Figure 5-15 and each is described in the following sub-sections. The concentrations of arsenic in soil that have resulted in elevated concentrations of soluble arsenic are generally greater 300 mg/kg but vary between each of these source areas. The depiction of source areas on Figure 5-15 represents the approximate lateral extent of each of the sources to groundwater and is intended only to aid the subsequent discussions on arsenic fate and transport.

Additional areas of elevated arsenic concentrations in soil and groundwater have been observed beyond the southern extent of OU1 throughout various portions of the former Lever Brothers property. One such area is along the shoreline of the former Lever Brothers near monitoring wells MW-51A and MW-109A. Due to its proximity to OU1, data from this area have been contoured and are discussed briefly below; however, the elevated concentrations of arsenic in groundwater in this area are unrelated to OU1. The arsenic concentrations in groundwater in this area are the result of reducing groundwater conditions in proximity to elevated concentrations of arsenic within the fill.

High-Concentration Arsenic Area

Within the northwest portion of the Quanta property and the southwest corner of the former Celotex property, the presence of reddish-purple soils consisting of partially burned (roasted) or unburned pyritic ore were documented as part of the RI. These reddish-purple soils are related to historical pyrite-roasting operations associated with the former acid plant. Reddish-purple soils generally coincide with arsenic concentrations greater than 1,000 mg/kg in soil and are present in thicknesses ranging from less than 1 foot to up to 6 feet. They are found at greater depths at the former Celotex property, where they have been covered with an impermeable liner and fill material as part of the construction of the roadway to the City Place development. The highest concentrations of arsenic in soil are generally observed along the border of these two properties; the highest concentration observed to date was 39,500 mg/kg at SRI boring SB-54 at approximately 10.5 feet bgs.

Groundwater geochemical conditions within in the HCAA include an acidic pH and high Eh with elevated concentrations of arsenic, iron, and sulfate, which are consistent with the acid waste-leaching process described in Section 5.3.1. Elevated concentrations of up to 800 mg/L of total phosphorus also indicate an abundance of orthophosphates. These orthophosphates compete with arsenic for iron oxyhydroxide adsorption sites and contribute to arsenic mobility.

ASA-1

An additional arsenic source area exhibiting an acid waste signature similar to that of the HCAA was identified during the SRI. Specifically, an isolated area of elevated arsenic concentrations in soil up to 7,040 mg/kg was detected in the northern portion of the former Lever Brothers property at boring SB-55 between 5 to 5.5 feet bgs. Although this sample and numerous others collected from this area at similar depth intervals during the RI have not indicated the presence of reddish-purple soils, the groundwater signature in this area suggests that arsenic in groundwater is the result of the oxidation of pyritic material (acid waste) at or just below the water table. The results of X ray diffraction analyses performed on a soil sample collected at ASA-1 between 0.9 and 1.6 feet bgs (SB-34-1.3) as part of the RI and discussed in Appendix N of that report did not indicate the presence of pyrite; however, thin section petrography analysis did reveal traces of finely crystalline pyrite (estimated at less than 0.3 percent) within the gas vesicles of one of the slag particles contained in that sample.

The data depicted in Figures 5-1 and 5-2 show that the footprint of this source area is limited and separate from the HCAA. As stated in the RI, increases in arsenic concentrations in shallow groundwater in this area relative to those upgradient suggest the presence of an arsenic source within the fill. The sample collected from SB-55 has confirmed this. Furthermore, increases in the concentrations of other acid waste byproducts in shallow groundwater at MW-107A such as iron and sulfate and the markedly lower pH and elevated Eh present in groundwater confirm that the presence of soluble arsenic here is the result of the oxidation of a localized source of pyrite not physically connected to the HCAA.

ASA-2

At Block 93 North, near the MW-111 series monitoring wells, existing RI data shows the presence of concentrations up to 988 mg/kg arsenic in the fill, as well as elevated

concentrations of soluble arsenic in groundwater. Soil and groundwater data as well as additional hydraulic head information collected to the west of the HCAA and within and to the west of Block 94 North have demonstrated that the presence of arsenic in groundwater here is the result of the dissolution of arsenic from localized hot spots within the fill deposits unrelated to the HCAA to the east. As part of the SRI this source area has been fully delineated and the approximate extent of this source area is illustrated in Figure 5-15 as ASA-2.

Groundwater conditions in ASA-2 are dramatically different than those observed in the acid waste source areas (HCAA and ASA-1). As illustrated respectively in Figures 5-6 and 5-8, iron and sulfate concentrations in this area are three orders of magnitude lower than what is observed in the HCAA and ASA-1. Based on the absence of elevated concentrations of these constituents in combination with the near-neutral pH and lower Eh in groundwater it is reasonable to conclude that pyritic material is not the source of soluble arsenic in groundwater here.

Mineralogical data collected and presented as part of Appendix N of the RI Report confirmed the presence of an abundance of black glassy slag associated with the fill and that pyritic material was not present. The SRI findings support the original RI conclusions, and although arsenic concentrations in soil are at concentrations at the high end of the range of what it is typically seen in fill, they are consistent with what has been observed sporadically throughout the heterogeneous fill deposits across the area, particularly near the former Lever Brothers property. Elevated arsenic concentrations within the fill in combination with mildly reducing conditions result in the reductive dissolution of iron and the release of soluble arsenic. Elevated concentrations of orthophosphates competing for iron oxyhydroxide adsorption sites are also contributing to the presence of soluble arsenic at ASA-2.

ASA-3

As discussed in Section 5.5.3 of the RI Report, an area of reduced groundwater with elevated concentrations of soluble arsenic exists along the shoreline of the former Celotex property. Soil and groundwater data collected as part of the SRI have confirmed that this area represents a separate source of arsenic to groundwater. Data collected from MW-134 indicate that arsenic is present in the saturated NAPL-impacted fill deposits associated with NZ-5 at concentrations up to 710 mg/kg in soil and 4,320 µg/L in groundwater. The distribution of arsenic in saturated soil and groundwater shown in Figures 5-2 and 5-5, respectively, indicate that these elevated groundwater concentrations represent a source area separate from the HCAA upgradient to the west. Furthermore, reduced concentrations of iron and sulfate in this area shown in Figures 5-6 and 5-8, respectively, as well as the near neutral pH and low Eh conditions in groundwater indicate an absence of a pyritic waste signature.

As with ASA-2, at ASA-3 an area of elevated arsenic concentrations within the fill in combination with specific geochemical conditions affected by the presence of dissolved organics in groundwater, including those associated with NAPL at NZ-5, are resulting in the reductive dissolution of iron and the release of soluble arsenic. The elevated concentrations of orthophosphates that compete for iron oxyhydroxide adsorption sites are also contributing to the presence of soluble arsenic at ASA-3.

5.3.3 Geochemical Zones

Geochemical zones previously identified in Section 5 of the RI Report have been refined and remapped in Figure 5-15 using major ion chemistry and field parameter data collected as part of the SRI. In general, geochemical zones were redrawn using sulfate, iron, and total phosphorus concentrations as well as Eh and pH data for groundwater.

Zones 1A and 1B

With an acidic pH, high Eh (+200 mV), elevated iron, sulfate, and arsenic, these zones are characterized by their acid waste leachate signature, which extends just beyond the downgradient edge of their associated source areas. The main difference between these geochemical zones is that Zone 1B has relatively low levels of total phosphorus in groundwater (generally less than 0.5 mg/L) whereas Zone 1A has some of the highest levels observed at the Site, with concentrations in groundwater of up to 800 mg/L.

Zone 2

Due to the presence of NAPL associated with NZ-5 groundwater in Zone 2 has elevated VOC and SVOC concentrations with low Eh (-100 mV), and a near-neutral pH. Groundwater here is sulfate reducing, resulting in lower Iron and sulfate concentrations and higher sulfide concentrations. Phosphorus concentrations are slightly elevated here and are at or above 1 mg/L.

Zone 3

Zone 3 represents the inland areas of organic groundwater contamination associated with the NAPL at OU1, as well as separate sources to the south of the groundwater convergence zone associated with the former Lever Brothers property. Groundwater in these areas has a near-neutral pH, low Eh (-100 mV), and varying concentrations of arsenic, iron, sulfate, and total phosphorus. Portions of this zone represent sulfate reducing conditions, particularly those areas along the shoreline at the former Lever Brothers property to the south where sulfate concentrations are lower and sulfide is elevated. The highest sulfate and iron concentrations are in the northern portions of Zone 3 downgradient of the HCAA and are greatest in the deeper unconfined groundwater. Total phosphorus concentrations vary from approximately 0.2 to 4 mg/L and tend to be higher in the deeper unconfined groundwater downgradient of the HCAA; unlike sulfate and iron, they are also elevated in the presence of arsenic at portions of Block 93.

Zone 4

Zone 4 represents nearshore areas of organic groundwater contamination associated with the NAPL at OU1 behind and south of the wooden bulkhead (predominantly NZ-2). It is characterized by a near-neutral pH, with generally lower Eh (less than 0 mV) and markedly lower sulfate, iron, and arsenic concentrations. Total phosphorus concentrations are also relatively low here, with concentrations near 0.2 mg/L.

Zone 5

As with the RI, this zone represents Site background. Groundwater has a near-neutral pH, with a transitional to suboxic Eh (+100 to +400 mV) and lower sulfate, iron, and arsenic concentrations. Total phosphorus concentrations vary throughout Zone 5 from below

detection to approximately 6.7 mg/L. The most oxic groundwater within Zone 5 is found along the foot of the palisades where recharge is localized and organic fill and meadow mat deposits are either thin or not present.

5.3.4 Attenuation

To better understand the effects of the varying geochemical conditions throughout the Site and confirm that attenuation of soluble arsenic is occurring at and downgradient of the identified source areas, additional specialty groundwater and soil analyses were performed. In addition, speciation modeling was conducted using the major ion chemistry and field measurements collected as part of the SRI. The following subsections discuss the results of these additional efforts as well the attenuation of arsenic along all key groundwater flow transects downgradient of each of the source zones illustrated in Figure 5-5. Multiple lines of evidence, including those developed from the extensive soil and groundwater data set available for the Site as well as the results from specialty analyses and geochemical modeling efforts support the conclusion that arsenic is attenuating along each transect.

Solid Phase Partitioning

A complex SEP was performed on select soil samples collected within and downgradient of the various source areas to determine the mechanisms for the solid phase partitioning of arsenic. These data support the conclusion that the HCAA and ASA-1 are related to pyritic waste and that ASA-2 and ASA-3 are not. Furthermore, SEP data provide additional direct evidence of ongoing arsenic attenuation and support the conclusion the dissolved phase arsenic at the Site is stable and in steady state.

Results of the SEP analyses show the relative percentages of arsenic in soil that are soluble and that are associated with different mineral phases within and downgradient of source areas. Depending on the phase with which it is associated, arsenic may be more or less easily solubilized in groundwater. The phase associations for arsenic evaluated using the SEP are listed in order of least stable to most stable:

- Soluble – readily dissociable and soluble arsenic contained within the pore space of the soil
- Easily exchangeable – adsorbed to outer-sphere complexes
- Amorphous iron oxyhydroxides – associated with poorly crystalline hydrous iron oxides
- Crystalline iron oxyhydroxides – associated with well-crystallized hydrous iron oxides
- Residual – encapsulated arsenic and thioarsenic or that which may be bound to organics

The most readily mobilized and transported arsenic is associated with the soluble and easily exchangeable phases. Amorphous and crystalline iron oxyhydroxides represent progressively more stable mineral phases in which significant alterations to the geochemical environment would be required to dissolve and release soluble arsenic. Residual arsenic is the most stable form in soil. The measured concentrations of arsenic and iron associated with each of these phases from samples collected across the Site are summarized in Table 5-1. The results for other ancillary elements, including manganese, calcium, magnesium, and

aluminum, are provided in the laboratory analytical report, in Appendix I. The relative percentages of arsenic associated with each of the five phases for each sample are shown in pie charts in Appendix DD, which have also been plotted on a Site plan and included as Figure 5-16.

Within acid waste source zones (HCAA and ASA-1), a greater percentage of arsenic is present in the soluble or easily exchangeable phases than is observed elsewhere. However, within and downgradient of these areas there are significant percentages of arsenic associated with amorphous iron-oxyhydroxides, which suggest that arsenic attenuation through sorption to these iron phases is occurring at the Site. Southwest of the HCAA (represented by SB-54), arsenic is associated mostly with both amorphous and crystalline iron-oxyhydroxides. In more reducing areas, such as geochemical Zone 2 (MW-134) and portions of geochemical Zone 3 adjacent to the river (MW-131 and MW-132), samples are consistently dominated by the residual (least mobile) fraction. Amorphous and crystalline iron-oxyhydroxides are absent due to reductive dissolution. At Geochemical Zone 3 this dissolution results in higher iron concentrations in groundwater (at or greater than approximately 10,000 $\mu\text{g/L}$), and when arsenic is present in the soils here, concentrations of arsenic in groundwater will also be higher, as in the case of ASA-2. Elevated iron concentrations are not observed in the sulfate reducing groundwater associated with Geochemical Zone 2 and portions of Geochemical Zone 3 at the former Lever Brothers property, as it has been removed from solution by the formation of iron-sulfide minerals. In these areas arsenic remains in solution.

The results of the SEP data refine the understanding of the variability of arsenic behavior across the Site. With the exception of the areas of reductive dissolution, the significant fractions of arsenic associated with the amorphous and crystalline iron-oxyhydroxides suggest that attenuation of arsenic through adsorption is occurring at the Site. However, despite the evidence of attenuation, SEP data from within and downgradient of zones HCAA and ASA-1 confirm that soluble and easily exchangeable phases are also present and that these fractions of arsenic remain mobile even beyond these source areas. Groundwater geochemical data suggest that this is likely the result of orthophosphates competing for the receptor sites and causing arsenic to remain in solution, resulting in the persistence of both parameters in groundwater at significant distances from these source zones. The specific geochemical dynamic and role of orthophosphates is discussed in context of each of these source zones for key groundwater transects in Section 5.2.4.

With the exception of two samples collected at MW-128 in March 2009, splits of all SEP samples were sent from the laboratory to the EPA's National Risk Management Research Laboratory in Ada, Oklahoma, where they were analyzed using the same procedures. The results of EPA's analysis using the same SEP procedure were documented in a technical memorandum dated March 11, 2009 (EPA, 2009a). In general, the results of these analyses correlated well with the analyses performed by Applied Speciation. A copy of the EPA's report is provided as Appendix EE.

Speciation in Groundwater

Selected groundwater samples from across the Site and shallow pore water samples from OU2 were analyzed for arsenic speciation using IC-ICP-DRC-MS in addition to total and dissolved arsenic to determine what fraction of the soluble arsenic present in groundwater

is the more readily adsorbed arsenate species, to determine which fraction was the more-reduced and more-mobile arsenite species, and to evaluate if there are any additional, less common forms of arsenic present in groundwater. Speciation modeling was also performed for Site groundwater using PHREEQC (Parkhurst and Appelo, 1999), which is a computer program used to simulate chemical reactions and transport processes in natural or contaminated waters. The speciation modeling used the extensive Site-specific geochemical data along with the MINTAQv4.dat database to calculate the distribution of aqueous species by using an ion-association aqueous model. These results can be compared to the direct measures of arsenic speciation to determine if kinetics (speed of the reaction) is playing a role in arsenic behavior at the Site as the modeling results represent equilibrium conditions and are indicative of the direction of the speciation reactions. The direct measurements illustrate the ephemeral state controlled by kinetics.

The laboratory and modeling results for arsenic speciation in groundwater are presented in Table 5-2. Speciation data for the shallow pore water samples are presented in Appendix R. In general, the dissolved arsenic concentrations and the sum of the species in groundwater showed fair correlation with a relative difference that was generally less than 25 percent. Exceptions to this included the results from monitoring wells MW-111B, MW-132 and MW-134, which are discussed below. Laboratory results for arsenic speciation in groundwater vary across the Site. However, with the exception of the groundwater at ASA-2 at Block 93 North, samples containing higher concentrations of arsenic generally consisted of a mix of arsenate and arsenite and were often dominated by the more mobile arsenite species. Where reducing conditions in groundwater have resulted in an abundance of arsenite the attenuation rates of arsenic are diminished. The pore water samples collected from the three sampling locations adjacent to the shoreline were dominated by arsenite; the two locations farther from shore contained higher relative concentrations of arsenate.

As shown in Table 5-2, arsenic speciation results generated using PHREEQC often predicted a dominant species of arsenic that was not congruent with what was directly measured. This is likely a result of the kinetics of redox reactions involving arsenic, which can take weeks to months (Cherry et al., 1979). Modeling reflects equilibrium conditions based upon pH and Eh, effectively predicting the direction of the speciation reactions at a given location, but the laboratory results provide a direct measurement of the ephemeral speciation state as controlled by kinetics. Based in these discrepancies it is probable that redox conditions in the alluvial aquifer undergo seasonal or even perhaps ephemeral changes that could affect the arsenic speciation. Arsenic speciation is noted to be slow in response to redox changes especially in the case in the shallow groundwater at the Site which will be subjected to additional fluctuations in redox conditions due to its closer proximity to the shallow vadose zone. In other words, the arsenic speciation may be trying to catch up with the redox changes and thus lag the measured redox potential more at some well locations than at others.

Split samples from select monitoring wells were collected by CDM during the SRI and shipped to the EPA's National Risk Management Research Laboratory in Ada, Oklahoma, where they were analyzed for total and dissolved arsenic and iron by ICP-OES; arsenite, arsenate, dimethylarsenic acid (DMA), and monomethylarsonic acid (MMA) species were determined by LC/ICP-MS. The results of the EPA's analyses were documented in a technical memorandum dated March 11, 2009 (EPA, 2009a). A copy of the EPA's report is provided as Appendix EE. Results of the laboratory speciation analyses for arsenite and

arsenate performed by both the Respondents' laboratory (Applied Speciation) and the EPA and the modeling output for the speciation for arsenic are summarized in Table 5-2. No concentrations of MMA or DMA were detected in any of the samples analyzed by the EPA. With the exception of one location, the results of the six groundwater speciation analyses performed by the EPA were comparable to those of Applied Speciation. The one discrepancy was observed in the samples from MW-111B, where EPA results (Sample ID MB5128) indicated that arsenic was composed almost entirely of arsenate, whereas Applied Speciation results indicated that significantly higher concentrations of arsenite were present at levels much greater than what was reported for the total dissolved arsenic. In addition, dissolved iron and arsenic concentrations at MW-111B were an order of magnitude lower than the results for these parameters reported by the EPA. The discrepancy between the dissolved arsenic and the sum of the species reported by Applied Speciation, as well as the fact that concentrations of dissolved iron and arsenic reported by the EPA were consistent with historical results from MW-111B, suggest that Applied Speciation data for this well are inaccurate either because of matrix interferences or as the result of a sample handling or laboratory error.

Although the sum of the species at MW-132 and MW-134 (EPA sample IDs B5025 and B5021, respectively) were not congruent with the reported total dissolved arsenic concentrations, this variance was observed in the results from both laboratories. Applied Speciation's and EPA's results for these samples indicated that dissolved arsenic concentrations as a whole were considerably higher than the sum of the individual arsenate and arsenite species, showing that perhaps an additional form of arsenic was present in these samples in significant concentrations. In their discussion of these results, the EPA suggested that this variance was due to the presence of thioarsenic (EPA, 2009a). This is consistent with the geochemical environment at both these locations, which represent some of the most reducing conditions (sulfate reducing) at the Site. In these locations, iron would reprecipitate as iron-sulfide minerals resulting in relatively low levels of dissolved iron in groundwater. The combination of these conditions can promote the formation of thioarsenic species (EPA, 2007), which may represent a component of the residual arsenic fraction observed in the SEP data these locations. Dissolved arsenic and speciation data for the nearshore shallow pore water samples collected at locations GWZ-2 and GWZ-5 also suggest that thioarsenic species may be present.

The analytical results for two shallow pore water samples collected farther from shore, GWZ-3 and GWZ-4, included dissolved arsenic concentrations below the detection limits; however the speciation analysis returned low level concentrations of arsenate and arsenite. Arsenate dominates the speciation at these two locations and the sum of the arsenic species are below the surface water screening criterion of 36 µg/L.

Groundwater Flow Transects

Five transects were developed to evaluate arsenic attenuation in groundwater throughout OU1. Transect 1 and Transect 2, as shown in Figure 5-5, illustrate the two primary flow paths moving away from the HCAA. Transect 3 extends westward from the HCAA onto Block 93 North and was developed to show that this is not a pathway for arsenic transport via groundwater. Transects 4 and 5 in Figure 5-5 represent secondary transport pathways for arsenic. Concentrations versus distance plots have been developed for each transect using select SEP and groundwater data and are included as Appendix FF.

Although geochemical conditions have resulted in a greater abundance of the more mobile arsenite species within and downgradient of some source areas and orthophosphates are competing with arsenic for iron oxyhydroxide adsorption sites, arsenic attenuation does appear to be occurring along all transects downgradient of source zones as evidenced in concentration versus distance plots shown in Appendix FF. This is based on the percent decline in arsenic concentrations over distance relative to the source term (i.e. the attenuation rate) which is consistently greater than that of sulfate along all transects. Greater attenuation rates for arsenic than sulfate, as well as the solid phases with which arsenic is associated, indicate attenuation through adsorption is occurring. Details are presented below for each of the groundwater flow transects relative the source areas and geochemical zones.

Transect 1. Arsenic originating from acid wastes associated with the HCAA (Geochemical Zone 1A) moves southward into Geochemical Zone 3 attenuating with distance but remaining at elevated concentrations because of competition by orthophosphates for sorption sites on the iron oxyhydroxides and the mildly reducing conditions caused by the presence of NAPL. South of 115 River Road groundwater encounters a second source of acid waste material (ASA-1) located in Geochemical Zone 1B in the northern portion of the former Lever Brothers property. Downgradient of Geochemical Zone 1A groundwater enters the transitional to suboxic Geochemical Zone 5, arsenic in shallow and deeper groundwater attenuates rapidly in this area due to decreased competition with orthophosphate for sorption sites. Beyond this zone groundwater encounters another reducing area (Geochemical Zone 3) associated with the former Lever Brothers property. The conditions in this area promote the precipitation of iron sulfide minerals, opposed to iron oxy-hydroxides, the reduction sorption capacity, in conjunction with increased competition from orthophosphates result in an increase in soluble arsenic adjacent to the river. Further attenuation of arsenic downgradient of Transect 1 within the river is also expected to occur based on shifting redox conditions. Shallow pore water samples will be collected in this area as part of additional environmental investigations being performed by GZA in behalf of iPark at the former Lever Brothers property.

Transect 2. Arsenic originating from acid wastes associated with the HCAA (Geochemical Zone 1A) also moves eastward along the southern edge of the former Celotex property, continuing downgradient through Zone 1A into Zone 5. Despite elevated orthophosphate concentrations and the acidic pH, arsenic attenuation is occurring along this transect within Zone 1A and has been reduced by several orders of magnitude as it enters Zone 5. Slight increases over time in arsenic concentrations at MW-C and MW-O are likely the result of filling and paving which have cut off the supply of atmospheric oxygen to the subsurface in this area. Farther east, reductive dissolution of arsenic sources within the fill is occurring in Geochemical Zone 2 due to NAPL Zone 5 adjacent to the river, resulting in elevated dissolved arsenic concentrations at MW-134. Shallow pore water samples collected from areas of groundwater upwelling downgradient of Transect 2 exhibited only low levels of dissolved arsenic in groundwater ranging from 15.3 to 33.8 µg/L and are strong evidence of further attenuation in the nearshore area. These low levels of arsenic are not affecting surface water here, as collocated surface water samples were below detection limits for arsenic.

Transect 3. Low concentrations of arsenic between the HCAA and Block 93 North as well as the refinements to the groundwater flow directions have shown that this is not a groundwater flow path; therefore arsenic is not being transported west from the HCAA through advection.

Transect 4. This transect represents a groundwater flow path beginning near MW-112B near the northern edge of Geochemical Zone 3 and that extends southeast to OU2 through MW-106A. Attenuation of arsenic is indicated by the steep decline of arsenic concentrations over distance as groundwater moves from Zone 3 to Zone 5. Slight increases in arsenic concentrations adjacent to the river at MW-106A are the result of more reducing conditions, increase in orthophosphate concentrations, and elevated soil arsenic concentrations due to fill in this environment. Within identified areas of groundwater upwelling downgradient of Transect 4, shallow pore water results collected from samples GWZ-4 and GWZ-5 suggest that additional attenuation of arsenic is occurring in the sediments at OU1. Concentrations of arsenic in surface water samples also collected at these locations were below detection limits.

Transect 5. The combination of arsenic sources in the fill (ASA-2), the presence of orthophosphates, and mildly reducing conditions have resulted in the presence of soluble arsenic in groundwater at Block 93 North at the MW-111 series monitoring wells. Groundwater here moves to the south where arsenic attenuates as it moves into the less reducing Geochemical Zone 5. Farther south, arsenic concentrations increase at MW-123, perhaps because of an additional source in the fill. Arsenic in groundwater along Transect 5 attenuates well before reaching the river.

5.3.5 Plume Stability

Based on data collected during the SRI, along with data collected as part of the RI, multiple lines of evidence support the conclusion that arsenic is attenuating in groundwater resulting in steady state conditions.

Statistical trend analyses were performed on concentration data collected from across the Site to provide a more balanced approach through consideration of the larger temporal dataset. Arsenic groundwater concentration trends (Appendix BB) indicate that the footprint of the plume is stable or shrinking, with the exception of one area at the former Celotex property (MW-C and MW-O), which showed a slight increase since sampling began in 2003. Using the Mann-Kendall Trend Test (EPA, 2000) the stability of the plume with the exception of these two wells was confirmed (Appendix CC). As noted above, redox conditions in the alluvial aquifer can undergo seasonal or even perhaps ephemeral changes. Changes in the redox state of both the saturated and unsaturated zones can affect arsenic speciation and result in fluctuations in the concentrations of redox sensitive constituents such as iron and arsenic. Unlike organic constituents, evaluations of arsenic plume stability need to consider these factors and the fluctuations of concentrations at individual data points should be evaluated in context of the larger temporal and spatial data set before determining whether the plume is shrinking, stable or expanding because of continued advective transport from source areas.

5.3.6 Discharge to OU2

The steady state conditions for dissolved phase arsenic described above are consistent with the observation that there is limited discharge of dissolved phase arsenic from OU1 into OU2. The results of the groundwater-surface water interaction assessment described in Sections 3.3.3 and 5.2.2 indicated that dissolved arsenic was not present in OU2 surface water at any of the sampled locations and that there is no measurable discharge of arsenic to surface water in the Hudson River because of upgradient sources at OU1. Dissolved arsenic was detected in pore water collected from the three locations nearest the shoreline (between 15.3 and 46.2 µg/L), with slightly higher concentrations on either side of bulkhead), but was not detected in the two locations furthest from the shoreline or in any of the surface water samples analyzed (Figure 5-5; Appendix P). With the exception of GWZ-2 which is the end of Transect 2 and adjacent to ASA-3, all concentrations of arsenic measured in nearshore pore water were higher than those observed in nearshore groundwater immediately upgradient at OU1, suggesting that sources of this constituent are present with the sediments at OU2. The factors controlling the fate and transport of arsenic within OU1 are also controlling the behavior of arsenic along the groundwater-surface water interface. Redox conditions affected by the presence of additional dissolved organics in nearshore areas associated with the presence of NAPL here may also promote the dissolution of arsenic that has been observed within the sediments throughout the Hudson River. The speciation data collected from the three locations along the shoreline indicate that the more mobile arsenite species is dominant at these locations.

Several lines of evidence support the conclusion that the arsenic detected in the pore water at GWZ-5 is a function of the surrounding sediment concentrations. The nearshore shallow sediments south of 115 River Road exhibit the highest concentrations of arsenic observed in OU2, with concentrations ranging from 51.9 to 90.2 mg/kg (CH2M HILL, 2007d). As previously noted, the fill material in this area has been characterized as containing an abundance of vesicular glassy slag material with concentrations of arsenic above screening the criterion; additionally pieces of hard asphaltic material are intermixed within the eroding fill adjacent to the shoreline. Behind and at the immediate flanks of the bulkhead where NAPL Zone NZ-2 is present, dissolved arsenic concentrations are all below the laboratory method detection limits and total arsenic has only been detected during the RI and SRI groundwater sampling at concentrations ranging up to 12.2 µg/L (MW-120B), which is relatively low. Higher concentrations of arsenic within the downgradient pore water provide evidence that sources of arsenic exist within the sediment. The redox conditions at this location favor the formation of ferric oxide minerals and arsenate; however, small shifts in pH or Eh can result in localized dissolution of the iron oxides and associated arsenic.

Location GWZ-1 also does not represent an area of arsenic discharge from OU1 to OU2 even though this is an area of where groundwater is physically discharging to OU2. The groundwater concentrations in wells upgradient of this location (i.e., MW-117A and MW-116B) have very low concentrations of total and dissolved arsenic and are not considered to be within the arsenic plume (Figure 5-5). As noted previously, deeper pore water samples collected directly in front of the bulkhead the PZ-3 piezometer cluster also had higher dissolved concentrations than the adjacent upgradient groundwater. The concentration gradients observed at this location, similar to that observed at GWZ-5, between the

unimpacted groundwater upgradient and both the shallow and deeper pore water at OU2 indicate that the presence and distribution of dissolved arsenic at OU2 is not the result of advective transport in groundwater from OU1 and that it is controlled, at least in part by its presence within the sediments as well as the redox conditions present here.

Unlike the conclusions derived in connection with the observation of arsenic at GWZ-1 and -5, the arsenic detected in pore water at location GWZ-2 may, at least in part, be attributable to groundwater discharge from OU1 to OU2. This location is adjacent to the shoreline area where dissolved arsenic concentrations in groundwater are elevated due to reductive dissolution of arsenic within the fill material, and hydraulic data indicate that an upward gradient exists toward the surface water at OU2 (Figure 3-12; flow net K-K'). The Eh-pH conditions of the subsurface at the depth at which the pore water samples were collected slightly favor the formation of iron oxy-hydroxides; however, the more labile arsenite species would still be predicted to be the dominant arsenic species (Figure 5-17). Given the predicted dominance of arsenite, the associated laboratory confirmation of the speciation, and the expected instability of the iron oxyhydroxides, some of the arsenic associated with the sediments is also expected to be in solution. The concentrations of arsenic in surface sediment in this area average 16.4 mg/kg.

Even though arsenic was detected in the shallow pore water it was not observed in surface water at detectable levels. This is likely the result of additional attenuation predicted to take place within the thin oxic zones in the top 12 inches of the sediment surface before groundwater moves to the surface water and experiencing rapid dilution. Oxidation would also be expected to occur in the thin oxic zones. The Eh-pH conditions measured in the subsurface sediment within OU2 represent a transition between the reducing conditions observed along the shoreline (lower Eh and lower pH) and the more oxidizing conditions measured in the surface water (Figure 5-17). These data indicate that ferric oxide minerals and the less soluble arsenate species would predominate at the sediment-water interface, and that further attenuation of arsenic would be expected in the very shallow, more oxic layers of the sediment in OU2. The pore water locations adjacent to the shoreline where arsenic was detected have the lowest Eh values of the five sampled locations (Figure 5-16); the speciation data are in agreement with the observed redox conditions, with arsenite dominating in the nearshore shallow pore water and a prevalence of arsenate in the two locations furthest from shore.

SECTION 6

Conceptual Site Model

This section updates the conceptual site model (CSM) using all data evaluated as part of the RI and SRI. This CSM presents the current comprehensive understanding of the Site characteristics, sources of contamination, migration pathways, and fate and transport of the contaminants and represents an update to the CSM presented in Section 6 of the RI Report. A graphical depiction of the CSM is provided as Figure 6-1.

Data collected during the SRI resulted in the following substantive refinements to the CSM:

- **Geology and Hydrogeology** – Additional soil borings illustrated that soft organic silts found directly beneath the fill in near the shoreline are not the same as the silty-clay deposits that are present at consistently deeper elevations beneath native sand deposits within the central and southern portions of the Site (Section 3.1.1). Thin layers of dense glacial till at the base of the unconsolidated deposits overlying the bedrock have also been identified and included (Section 3.1.1). The effects of shoreline stratigraphy and the bulkhead on the Site hydrogeology have been determined and zones of groundwater upwelling in OU2 were identified (Section 3.3.2). The groundwater flow regime west of the Quanta property, near Blocks 93 and 94 has also been determined (Section 3.3.1).
- **Secondary Sources** – An additional secondary source of NAPL and soil impacts containing non-coal tar petroleum hydrocarbons present in the northeast corner former Lever Brother property adjacent to a former AST has been included in the CSM (Section 4.1.3). Data collected during the SRI also allowed a sixth NAPL zone to be identified and delineated (Section 4.1.3). Four secondary source areas of arsenic to groundwater have also been identified and delineated (Section 5.3.2)
- **Migration Pathways** – The understanding of the migration pathways for NAPL at the Site have been refined based on viscosity data and the identification of NZ-6 (Section 4.1.3). Data collected during the SRI also furthered the understanding of arsenic fate and transport (Section 5.3.4). This component of the CSM has also been updated to include the migration of NAPL and NAPL constituents (Section 4.4.2) and arsenic (Section 5.3.6) toward OU2.

The comprehensive CSM is presented below.

6.1 Current Land Use

The former Quanta Resources property was bisected in 1995 and 1996 by the realignment of River Road, which now runs north-south through the western portion of OU1. The current 5.5-acre land portion of the Quanta property is a vacant lot. The ground surface is primarily exposed gravel with the remains of concrete tank and building foundations and is sparsely covered with stands of small trees and tall grass.

The Celotex property that borders the Quanta property to the north contains a mixed-retail and residential complex that includes a hotel, with a parking area on the south portion of the property. South of the Quanta property lies the 115 River Road office complex and the i.Park Edgewater, LLC, (former Lever Brothers) property. A small commercial building is on the northwest corner of the former Lever Brothers property. Block 93 is west of the Quanta property between River Road and Old River Road. Block 93 North contains a small restaurant building. Block 93 Central contains a large, multistory abandoned building and a small abandoned two-story building formerly associated with a railroad in this area. Block 93 South is primarily a parking lot with a small medical building and a municipal pump house building.

6.2 Geology and Hydrogeology

Ten to 15 feet of fill material is generally present throughout the Site where it has been observed in thicknesses that ranges from 2.5 to 35 feet thick and consists of variable amounts of silt, sand, gravel, rock, building debris such as concrete, and brick, wood, cinders, and slag and miscellaneous organic and inorganic debris. Underneath this layer of fill material within the central portions of OU1 is approximately 20 feet of fine to medium-coarse sand. Along the shoreline, fill material has been placed on a layer of soft organic silt. The silt is up to 68 feet thick and consists of soft grey-to-black organic silt containing wood, roots, and shell fragments; this layer represents former river sediments and pinches out against the native sand toward the west. Also present directly beneath the fill in the western and southern portions of OU1 are discontinuous layers of meadow mat or peat deposits up to 25 feet thick. Layers of the native sand are also often present beneath the peat and organic silt deposits. A silty-clay confining layer underlies the native sand and peat; it is a barrier to groundwater movement and NAPL migration, and does not constitute a water-bearing unit. Underneath the silty clay confining unit is a deep sand unit up to approximately 32 feet thick that is unaffected by Site constituents due to the presence of the overlying confining layer. Beneath the deep sand unit is glacial till, consisting of up to 12 feet of a very dense, reddish-brown to reddish-yellow silty sand and sand with gravel, cobbles, and boulders. Bedrock is encountered at the Site between 8.5 to 86 feet bgs, with a bedrock high in the south-central portion of the former Celotex property. Both the deep sand and overlying silty-clay layers pinch diminish against this sharp rise in the bedrock surface toward the north and northwest, where only native sands and thin layers of glacial till are found between the fill and the surface of the bedrock. Three distinct overburden hydrostratigraphic units exist at the Site above the bedrock surface: the shallow, unconfined water table unit; the silty-clay confining unit; and the deep sand unit.

The direction of shallow groundwater flow is predominately southeast toward the Hudson River, with a linear flow velocity of approximately 0.55 foot per day. In general, groundwater flow directions and velocities are not substantively affected by tidal fluctuation of the Hudson River except near the wooden bulkhead on the Quanta property adjacent to the Hudson River.

A radial flow pattern in shallow groundwater has resulted from the presence of the bedrock high to the north, in combination with localized mounding that has resulted from the presence of shallow low permeability peat and increased recharge in the relatively low-lying

and unpaved ground surface in the northwest corner of the Quanta property. Most of the groundwater at the Site is forced southward into the northern portion of the former Lever Brothers property, where it eventually turns southeast and converges with groundwater originating from central portions of this Lever Brothers property. Groundwater flowing eastward on the Quanta property encounters the wooden bulkhead, which causes mounding to its west of the bulkhead and flanking of groundwater towards the north and south. Farther north, on the southern portion of the former Celotex property, groundwater flows in an easterly direction, toward the Hudson River north of the wooden bulkhead. To the west, near Block 93 and Block 94, groundwater flows from the foot of the Palisades predominately southward prior to traveling southeasterly towards the Hudson River.

Groundwater flow direction in the deep sand aquifer is more uniform, running predominately east-southeast with linear flow velocities of 0.01 and 0.02 foot per day under low- and high-tide conditions, respectively.

At the shoreline and within the sediments at OU2, strong upward vertical gradients are present because higher hydraulic heads in the bedrock and deep sand units provide a strong upward force near the river. As groundwater moves from OU1 to OU2 through leaks in the bulkhead and, to a greater extent, around the northern and southern sides of the bulkhead, groundwater is driven upward through the sediments and discharges to the surface water at OU2. The predominance of groundwater upwelling at OU2 is occurring in preferential discharge zones at the ends of the bulkhead, particularly the southern end, or in discrete nearshore areas adjacent to the bulkhead where hydraulic data suggests leakage is occurring. The upward forces of groundwater flow are not as pronounced along the shoreline farther south, beyond the bulkhead, where the bedrock and deep sand units are at a significantly greater depth. South of 115 River Road (and south of the bulkhead) the vertical gradients are more subdued and generally flat. Farther south, most of the groundwater discharge in this area is occurring slightly farther from the shoreline. The vertical gradients, however, do not provide information regarding the mass flux of groundwater and dissolved constituents. This information will be collected during the design phase of the FS if necessary to support the selection or design of an alternative.

6.3 Primary Sources

The primary sources of the regulated constituents present in soil and groundwater at the Site were the structures and processes associated with the long history of industrial operations at or near the Quanta property.

Within the extent of the former Quanta Resources property, historical operations consisted of coal tar processing and, subsequently, oil-recycling operations. Presumably, operations involving leaks from tanks, pipes, and/or other equipment throughout the industrial history of the property resulted in the release of various materials, including coal tar. As described by Weston (1985), later releases following operational shutdown occurred as the result of periodic Site flooding, seams and valves rusting, pipes and tanks freezing and thawing, and tanks overflowing due to precipitation. At the time that initial removal actions were proposed, the property had 61 ASTs and up to 10 USTs. The total cumulative storage capacity of the tanks was over 9 million gallons. Together, the tanks and processes that were present during and following active operations at the Site represent primary sources of soil and groundwater

impacts associated with the Site. These primary sources were removed between 1984 and 1988 during removal actions performed by the respondents; however, as is common in facility decommissioning, some buried piping remains in place on the Quanta property.

In addition to coal tar processing and oil-recycling operations, the operations of a former sulfuric acid plant in the northwest corner of the Quanta property and the southwest corner of the former Celotex property has resulted in the presence of unburned or partially burned pyrite in soils. Observations of reddish-purple soils and consistently elevated concentrations of various metals correlate well with the historical documentation of the former footprint of the acid plant on the former Celotex property. Based on their proximity to the historically documented footprint of the former ore burners and pyrite storage areas, as well as their mineralogical signature, this material is likely the result of accumulations of unburned or partially burned pyrite near where these materials were once stored and handled.

Primary sources unrelated to former Site operations also contributed to the presence of regulated constituents in groundwater and soil within the lateral extent of OU1 (PMK, 2000; RI Report [Appendix A]). These primary sources include the following:

- Fill material imported in the mid-1800s to raise the topographic elevation for the development of rail lines and industry along the Hudson River; fill is known to contain significant quantities of coal, coal ash, wood ash, cinders, and slag
- Various releases or incidental spills associated with metals reclamation, waste oil recycling, gypsum board manufacture, film developing, chemical storage, and vegetable packing and storage at the former Celotex property
- Manufactured-gas and other historical operations at the former Lever Brothers property, which have resulted in several identified AOCs at the property
- Potential releases or incidental spills during loading, off-loading, or other historical operations at the former Spencer Kellogg property
- An unidentified upgradient release of chlorinated solvents
- Former general use of pesticides

6.4 Secondary Sources

Because of some of the primary sources, secondary sources remain present at the Site today and continue to impact soil and groundwater. These secondary sources at OU1 include the following:

- NAPL in the subsurface, which is a continuing source of constituents – primarily aromatic VOCs, PAHs, and select SVOCs – to soil and/or groundwater
- Surface and subsurface soils at various locations throughout OU1 containing VOCs, SVOCs, pesticides, PCBs, and metals because of Site-related or non-Site-related primary sources

- Undifferentiated hydrocarbon LNAPL on the former Lever Brothers property, a continuing source of organic constituents to soil and groundwater that appears to be related to former soap manufacturing
- NAPL and soil impacts containing non-coal tar petroleum hydrocarbons present in the northeast corner former Lever Brother property adjacent to a former AST
- Solid tar, a source of VOCs and SVOCs to soil and, to a lesser extent, groundwater
- Pitch/asphalt materials on the former Lever Brothers property, a continuing source of aromatic VOCs, PAHs, and select SVOCs to soil and groundwater
- Unburned or partially burned pyrite ore in the northwest corner of the Quanta property and the southwest corner of the former Celotex property, which oxidizes to produce iron oxide minerals and releases impurities such as arsenic, iron, lead, copper, antimony, and thallium from the oxidized pyrite ore to soil and in some cases groundwater
- A smaller zone of pyritic material within the fill in the northern portion of the former Lever Brothers property
- AOCs at the former Lever Brothers property, the source of small areas of PAHs, non-PAH SVOCs, VOCs, metals, and PCBs
- Up to 32 feet of fill material throughout the Site contributing to the occurrence of PAHs and metals including lead and arsenic in soils and nearshore sediments, and, in some cases to groundwater when the geochemical environment is conducive(i.e., Block 93 North and along the shoreline on the former Celotex property).

6.5 Migration Pathways

Primary sources are no longer present at OU1, except for buried piping on the Quanta property. Direct releases to surface and subsurface soil (potentially including soil below the water table) have occurred in the past, as described in Section 6.3 of the RI Report. The extent of contamination at the Site is a function of the location of former or current primary sources and the ability of constituents to migrate from the resulting secondary sources in soil and groundwater. Mechanisms that control migration and their effect on contaminants associated with the secondary sources are discussed below.

6.5.1 Non-Aqueous Phase Liquid Migration

NAPL at OU1 consists of a wide range of individual constituents, each of which partition differently to other media on the basis of their characteristics. When NAPL is released directly to soil, its migration is controlled by gravity, hydraulic forces, the slope of the surface of any impermeable units, the characteristics of the bulk NAPL mixture itself (e.g., density and viscosity), and the presence of other constituents (e.g., petroleum products) that may enhance the mobility of NAPL constituents. Most of the NAPL at the Site is a separate-phase hydrocarbon liquid slightly denser than water. Smaller amounts of LNAPL have been observed in several wells near the shoreline at the Quanta property. A localized area of LNAPL not associated with OU1 has been observed farther south in the northern portion of the former Lever Brothers property.

Residual and free-phase NAPL at OU1 occurs in subsurface shallow soils as discrete deposits above, and within the top few feet of, the confining layer. At most locations within OU1, NAPL has reached steady state and is no longer migrating under current conditions. However, portions of deeper NAPL within the central portion of the Site and along the shoreline have characteristics that suggest the potential for mobility.

Under existing conditions, residual NAPL is trapped by capillary forces. Overall, Site-related NAPL has migrated vertically to a maximum depth of approximately 32 feet bgs. Most of the less-viscous tar that has migrated downward in the central and southern portions of OU1 resides within a natural depression in the top of the silty-clay confining layer, which prevents further vertical migration. A portion of the silty-clay confining layer along the southeastern edge of this natural depression dips downward below the organic silts and is overlain by native sand. Here the deeper NAPL is present only as thin and discontinuous lenses, indicating that to date it has not been able to migrate beyond this natural depression. If additional lateral migration were to occur, it would follow the surface of the silty-clay to deeper elevations, where there would be no potential for it to migrate to surface water, to sediments, or to air or to act as a source for direct exposure.

Along the shoreline, the wooden bulkhead impedes further NAPL migration towards the east, and as a result, NAPL has migrated south and north beyond the extents of the bulkhead. It cannot be assumed that the bulkhead serves as a complete barrier, as NAPL seepage has been observed along the shoreline in the nearshore area. NAPL has also been observed in the sediments of OU2, at elevations similar to those immediately adjacent to the bulkhead in OU1 (GeoSyntec, 2000; CH2M HILL, 2007d). Stratigraphic interfaces where NAPL saturation levels are highest along the shoreline slope downward south and north as well as east. This architecture, along with the presence of some less-viscous NAPL, particularly north of the bulkhead, indicates that a portion of the NAPL behind and north of the bulkhead has the potential to be mobile. NAPL south of the bulkhead in the northeast corner of the former Lever Brothers property appears to be residual and is close to non-Site-related NAPL and soil impacts associated with the former Lever Brothers property.

The potential for altering subsurface conditions that could induce a role in NAPL mobility is an important consideration for the Site. The effects of future development activities, such as excavation and placement of fill material, placement of subsurface structures, and pumping of groundwater, need to consider the presence of NAPL and potential for inducing NAPL mobility when specific development plans have been defined.

6.5.2 Advection

Dissolved-phase impacts of SVOCs, metals, ammonia, and PCBs are confined to the shallow fill and native sand deposits above the silty-clay aquitard. The rate of migration of constituents in groundwater is dictated largely by the direction and velocity of the groundwater flow, and constituent-specific attenuation (i.e., retardation) factors; the effects of the latter are described in the following sections. Dissolved-phase VOCs, PAHs, non-PAH SVOCs, and – to a lesser degree – arsenic migrate for variable distances in groundwater to various extents before attenuation has resulted in their removal from the dissolved phase. The rate of transport in groundwater is significantly slower than that of the bulk groundwater flow, and the concentration rate varies based on the retardation of individual constituents. Groundwater near the Site flows radially under current conditions. Dissolved-

phase impacts are found predominantly in the shallow unconfined unit and do not flow to the confined deep sand unit. Eventually, both the shallow unconfined and deeper confined groundwater discharge to the surface water of the Hudson River.

6.5.3 Partitioning

Partitioning is one of the most important mechanisms influencing the migration of constituents at OU1. Constituents at the Site can be present in NAPL, sorbed to soil, dissolved in groundwater, or present as a gas in soil vapor above the water table. Partitioning among these media is governed by subsurface conditions and by the characteristics of individual constituents.

Organic Constituents

At OU1, PAHs and aromatic VOCs are the primary component of NAPL, although non-PAH SVOCs and other organic compounds are also present. PAHs are found sorbed to soil particles above and below the water table. In general, SVOCs including PAHs have low water solubility and increasingly tend to adsorb to soil or particles within groundwater with increasing soil organic carbon in the soil. Sorption to soil particles is the process primarily responsible for their removal from aqueous systems. Although SVOCs generally do not leach to groundwater because of their strong propensity to adsorb, the amount of PAHs and more-soluble non-PAH SVOCs associated with NAPL have apparently exceeded the available adsorption sites at and near source areas.

Dissolved-phase naphthalene and, to a lesser extent, other, less-mobile PAHs are migrating from nearshore NAPL sources at OU1 toward the Hudson River. As groundwater moves into the pore water at OU2 it encounters additional sources of NAPL and adsorbed constituents present in the sediment here. Despite these additional sources, as the dissolved PAHs move upward through the sediments in OU2, they are subject to further attenuation (e.g., adsorption) and they are present at significantly lower concentrations in the shallow nearshore pore water compared to the concentrations measured in the monitoring wells adjacent to the Hudson River at OU1. Volatilization from soil might be significant for low-molecular-weight SVOCs but not for higher-weight SVOCs. However, since Site-related constituents at OU1 have been in place for at least 25 years and possibly up to 130 years, most potential volatilization of SVOCs likely has occurred already. Where present, impervious ground covers (buildings and asphalt) prevent soil gases from escaping to the atmosphere from the vadose zone. Significant volatilization of constituents from surface soil is not expected to occur unless surface soil is disturbed.

Aromatic VOCs such as benzene tend to be mobile, poorly adsorbed and therefore are found primarily in saturated soil and groundwater rather than in unsaturated soil. Aromatic VOCs such as benzene have a strong tendency to biodegrade and volatilize. Similar to PAHs, they have been subjected to increased further attenuation despite the additional sources within OU2. Their concentrations in shallow nearshore pore water are significantly lower than those measured in the monitoring wells adjacent to the Hudson River at OU1.

Upon reaching surface water, both PAHs and aromatic VOCs are subjected to volatilization and photolysis, which may be contributing to the further reductions in concentrations. As noted in Section 4.4.2, pore water and surface water concentrations decrease rapidly with distance from the shoreline. Pore water collected at identified groundwater upwelling zones

between approximately 300 and 350 feet from the shoreline does not contain detectable concentrations of these organic constituents due to the longer flow paths and the additional attenuation that groundwater is subjected to prior to reaching the shallow pore water. Movement of the pore water and associated organics is restricted because of the organic-rich, silty clay nature of the river sediments adjacent to the Site.

Due to their minimal and sporadic occurrence at low-level concentrations in soil at the Site, chlorinated VOC transport in soil via leaching or volatilization is not believed to exist at any measurable scale. Chlorinated solvents at OU1 have been detected primarily in groundwater samples collected from the confined deep sand unit; therefore, volatilization of chlorinated VOCs from this groundwater to soil vapor and the repartitioning of these constituents to soil are not anticipated to occur. Deep sand groundwater on the Site generally flows in an easterly direction, and eventually discharges to the Hudson River. Upon its discharge to the river, TCE is expected to volatilize rapidly. TCE was not detected in the shallow pore water or surface water downgradient of OU1 during the SRI.

PCBs detected at OU1 were present almost exclusively in soil, with only one historic offsite detection in groundwater. PCBs sorb strongly to soil and have minimal mobility. As a result, PCBs at OU1 are found primarily in contiguous areas of soil near the ground surface source (e.g., the oil-recycling operations). Although the volatilization rate of PCBs from water and soil surfaces may be low, the total loss by volatilization over time could be significant because of their persistence and stability in the near surface soil. In water, a small amount of PCBs might remain variably dissolved, but most is sorbed to organic particles and thus do not migrate in groundwater.

Pesticides have been detected sporadically at OU1; however, the detected pesticides have leached only partially, if at all. Detections of pesticides in groundwater could be a result of constituents adsorbed to saturated soil. The random near-detection-limit-concentration distribution of pesticides in groundwater, as well as their chemical characteristics, indicates that they are not mobile in groundwater at the Site. No known source of pesticides is known or identified within the Site.

Metals

Dissolved phase arsenic at the Site is attenuating and generally in steady state. The foremost source of arsenic iron and lead within OU1 include the remnants of pyrite source materials (reddish-purple soils) within the footprint of a former acid plant (HCAA). A separate and smaller area of pyrite exists in the fill at the former Lever Brothers property. Other sources of metals including arsenic and lead are the results of the ubiquitous presence of heterogeneous fill material containing coal, coal ash, and slag. Within the pyritic source areas the presence of arsenic and dissolved metals in groundwater are products of the pyrite oxidation as it is exposed to percolating rain water and groundwater and the subsequent release of arsenic and other impurities. Alternately, elevated concentrations of arsenic elsewhere are associated with the fill material. These hot spots in the fill are present at several isolated areas throughout OU1, including shoreline areas. At these different source areas the release of arsenic to groundwater is a function of the geochemical environments within which these hotspots reside. Specifically, dissolved organics resulting from the presence of NAPL and organic-rich fill and peat deposits promote arsenic mobility by reducing the affinity for arsenic to adsorb and causing the reductive dissolution of iron

oxyhydroxides that provide important adsorption receptor sites for arsenic and other metals. Within and downgradient of both the pyritic source zones and sources of arsenic in the fill, orthophosphates in the groundwater that are an artifact of the coal tar distillation process are significantly limiting the attenuation of arsenic in groundwater because the orthophosphates compete with arsenic for the iron oxyhydroxide receptor sites.

Despite orthophosphate competition, attenuation of arsenic is occurring downgradient of both pyritic source areas and areas of reductive dissolution through adsorption. Trends in the concentrations of arsenic over time within and along the leading edge of plumes indicate that the footprint of the arsenic plume is stable. SEP data support the conclusion that dissolved phase arsenic is attenuating. One exception is an area within the northern part of the former Celotex property, where filling and paving in 2003 have significantly reduced the atmospheric oxygen flux to the groundwater system and thereby enhanced the reductive dissolution of iron and increased mobility of arsenic. Arsenic associated with inland pyritic and fill-related sources, including the HCAA, is not affecting the pore water or surface water at OU2.

Isolated areas of elevated arsenic concentrations in groundwater associated with the fill along the shoreline have been subjected to attenuation and mineralization in OU2 because of the shifting redox conditions within the sediment near the surface water-sediment interface. This has resulted in concentrations of arsenic in shallow, nearshore pore water in close proximity to these upland sources that are significantly lower than those measured in adjacent upland monitoring wells. In other areas, advection of arsenic from OU1 to OU2 is not occurring and arsenic concentrations measured within the shallow and deep pore water in OU2 are the result of sediment concentrations and redox conditions driven by the presence of NAPL equilibrium. Surface water samples collected at these nearshore areas show an absence of arsenic. Concentrations of arsenic in the surface water of OU2 were below detection limits, suggesting that a measurable flux of arsenic from nearshore fill and the sediments to the surface water of the Hudson River is not occurring. Concentrations of arsenic in surface sediments in the Hudson River adjacent to OU1 are comparable to concentrations in samples collected both upstream and downstream of the Site (CH2M HILL, 2007d).

6.5.4 Abiotic and Biotic Transformations

Geochemical conditions of groundwater indicate microbial activity; thus, biodegradation of organic constituents is occurring at the Site (Section 5.5 of the RI Report). Biodegradation rates for PAHs, PCBs, and pesticides are limited by their dissolution into the aqueous phase. Adsorbed PAHs and PAHs in NAPL are unavailable to PAH-degrading organisms.

Therefore, in areas of residual and free-phase NAPL, biodegradation is not a significant attenuation mechanism. However, along the leading edge of the dissolved phase plumes of relatively soluble constituents such as naphthalene and benzene, microbial processes appear sufficient to stabilize and prevent the further migration of organic constituents.

Biodegradation is not considered to be a significant attenuation mechanism for inorganic constituents at the Site with the exception of Site-related ammonia, which is being attenuated to nitrogen gas under mildly oxidizing to reducing conditions and therefore does not migrate to the Hudson River. SVOCs and VOCs do not generally bioaccumulate. However, inorganics, pesticides, and PCBs will bioaccumulate. The absence of aquatic life at

OU1 diminishes the importance of bioaccumulation. Although the plants and trees present at the Quanta property could be bioaccumulating constituents, these plants most likely will be removed during any remedial actions at the Site and thus do not represent a significant migration pathway. The ability of aquatic and other organisms to bioaccumulate Site-related constituents identified in OU2 will be evaluated as part of the OU2 RI/FS.

6.5.5 Erosion

Constituents sorbed to surface soil particles might be transported along with those particles during the process of erosion, including entrainment in runoff during storm events or in the air under dry, windy conditions. The transport of current Site constituents via runoff or wind transport is minimal because a large majority of OU1 is covered by asphalt, concrete, vegetation, or gravel. However, control of transport via these migration pathways would be an important consideration during any potential construction activities at OU1 that may disturb the existing surface conditions within OU1.

6.6 Potential Pathways and Receptors

Because of the sources and transport mechanisms described, Site-related constituents at OU1 are present in various media, including surface and subsurface soil, groundwater, and to a lesser extent, soil vapor. Sediment and surface water in the Hudson River are being evaluated as part of the RI for OU2. When humans or ecological receptors are exposed to these media, constituents present in the media may pose risk to the receptors.

6.6.1 Ecological Risk Pathways and Receptors

The Site is located in an urban area with little or no habitat available for receptor population. Therefore, it was determined to be unlikely that many ecological receptors actually inhabit OU1. Without the presence of receptors, the ecological exposure pathway at the Site is incomplete, and no ecological risk is posed by constituents. The potential ecological risks due to Site-related constituents in the nearshore area will be determined by the OU2 baseline ecological risk assessment.

6.6.2 Human Health Risk Pathways and Receptors

Five human receptor types were identified with the potential for exposure to one or more media at OU1 potentially containing Site-related constituents. Trespassers/visitors could be exposed to constituents in surface soil under current or future conditions through dermal absorption or ingestion, or to ambient air through inhalation. Commercial workers, daycare children, and residents have the potential to be exposed to constituents in groundwater or surface soil through either ingestion or dermal absorption, and to constituents in ambient and indoor air through inhalation. Construction and utility workers could be exposed to constituents in groundwater through dermal absorption, to constituents in ambient air via inhalation, or to constituents in subsurface soil through ingestion or dermal absorption.

SECTION 7

Human Health Risk Assessment

[Forthcoming. This section is under a separate track since the HHRA for Block 93 Central and South needs to be completed.]

SECTION 8

Summary and Conclusions

Data were collected during the SRI to address specific data needs identified during the RI and agreed upon by the agencies as part of the approved SRI Work Plan. The additional data and evaluations associated with the SRI have successfully addressed the eight specific objectives outlined in the approved SRI Work Plan. This report in conjunction with the final RI Report (provided as Appendix A) serves as a comprehensive site characterization and completes the RI process for the Site. The conclusions related to the eight SRI objectives are presented in the table below. The findings of the SRI work have also been used to update the summary and conclusions for the RI process as a whole. The following subsections represent the comprehensive summary and conclusions for the RI process, and supersede those in Section 8 of the final RI Report.

8.1 Site Setting and Background

Operable Unit 1 consists of the current Quanta property (Block 95, Lot 1, between River Road and the Hudson River bulkhead), the 115 River Road property, and portions of the following additional properties:

- The former Celotex property to the north
- The former Lever Brothers property to the south
- Blocks 93 North, Central, and South and Block 94 to the west
- Block 92.01 to the northwest
- Portions of Old River Road, Gorge Road, and River Road

The total land area of OU1 encompasses approximately 24 acres. A tidally influenced mud flat-marsh associated with the Hudson River borders OU1 immediately east of the wooden bulkhead. River sediments immediately east of the bulkhead consist of silt to clayey silt over 50 feet thick. The wooden bulkhead spans the central portion of OU1 where it meets the river and extends through the soft river sediments to the top of the native sand or glacial till deposits, which are between 28 and 30.5 feet bgs at the Quanta property. Impacts to sediment and surface water (i.e., OU2) are being addressed under a separate Administrative Order on Consent.

Prior to the mid-1800s, the Site and surrounding areas were tidal marshlands associated with the Hudson River. Development of rail lines and industry along the banks of the Hudson River prompted the systematic infilling of these marshlands. Fill material during this timeframe is known to have contained coal, coal ash, wood ash, cinders, and slag. This fill material contains varying concentrations of PAHs and metals that can often exceed regulatory soil cleanup criteria and affect groundwater.

From approximately 1872 to 1971, a large portion of the Site was used to process coal tar and to produce paving and roofing materials. In 1974, a portion of the Site was reoccupied and leased for oil recycling, which continued until NJDEP stopped all activities in 1981, when it discovered that the storage tanks contained waste oil contaminated with PCBs.

SRI Objective	Key Conclusions
1. Determine the nature and extent of Site-related constituents and arsenic near Block 93 and the northwest portion of the former Lever Brother's property and in the intersection of Gorge and River Roads.	<p>The identification of contiguous NAPL within the intersection of Gorge and River roads represents a new finding of the SRI that has led to the addition of a sixth NAPL zone (NZ-6), which is present between 8 and 15 feet bgs and is present mainly in the fill layer to the depths of the peat unit. NZ-6 has been fully defined and has not migrated to the silty clay unit (Section 4.1.3).</p> <p>The extent of Site-related constituents in soil has been defined at Block 93 (Section 4.2.1; Section 5.1.1).</p> <p>The extent of Site-related constituents on Block 94 has been delineated. The western extents of Site-related constituents in soil can be inferred to extend only to where the Palisades bedrock formation outcrops (Section 4.2.2; Section 5.1.1)</p> <p>North of the Gorge and River Roads intersection, Site-related constituents in soil have been defined. (Section 4.2.3; Section 5.1.2).</p>
2. Determine the nature and extent of NAPL in the northeastern portion of the former Lever Brother's property (near MW-106A)	<p>The extent of NAPL near Block 93 Central and South has been defined and includes NZ-1 and NZ-4. No NAPL was detected during activities conducted on Block 94 (Section 4.1.2; Section 4.1.3).</p> <p>NZ-1 is found as far west as MW-40 (Block 93 Central) and NZ-1 was extended beneath River Road. NZ-1 has not migrated to the silty clay unit but is mainly found nearer to the water table (mainly between 1 and 12 feet bgs). In some areas it is confined by the peat unit. Its elevated viscosity and interfacial tension are also limiting vertical migration (Section 4.1.3; Section 4.1.4).</p> <p>NZ-4 extends from the northwestern portion of the former Lever Brothers property and across River Road onto Blocks 93 Central and 93 South. Vertically, NZ-4 is confined by either the peat or the silty clay unit. Analytical data indicate coal tar with a high viscosity, suggesting that future migration may be limited (Section 4.1.3; Section 4.1.4).</p> <p>The northern extent of NAPL along the shoreline has been revised in consideration of numerous historical borings on the former Celotex property. To the south along the shoreline the extent of NAPL has been extended to accommodate the identification of thin lenses of Site-related NAPL that were identified during TarGOST® and soil boring work (Section 4.1.2)</p> <p>The southern extent of Site-related NAPL along the shoreline has been defined and is part of NZ-2, which is also observed at the 115 River Road and Quanta properties. NZ-2 NAPL has migrated south from the Quanta property and eastward toward OU2 (Section 4.1.3).</p> <p>NAPL near MW-106A consists of non-coal tar weathered petroleum hydrocarbons. Analytical data indicate that the NAPL in this vicinity is not Site-related (Section 4.1.3).</p> <p>TarGOST® borings detected the presence of NAPL near MW-7. Analytical data indicate that the NAPL in this vicinity is not Site-related; the data indicated similarities with the NAPL collected near MW-106A (Section 4.1.2).</p>

SRI Objective	Key Conclusions
3. Refine nature and extent of NAPL behind and at the flanks of the wooden bulkhead	<p>NAPL (NZ-2) immediately west of the bulkhead is deeper than most previous RI data had suggested. It has been observed at depths of up to 25 feet bgs NAPL and does not extend beneath the base of the wooden bulkhead. The bulk of NZ-2 NAPL is present at the base of the fill material and the top of the soft organic silt. This organic silt unit was previously mapped as the silty clay aquitard, but it is now known to be a separate unit not contiguous with the silty clay (Section 4.1.3; Section 3.1.1).</p> <p>MW-116DS is not screened within the deep sand unit The deep sand unit is not present at this location. MW-116DS is screened in a till unit that was observed beneath the soft organic silt unit in this boring and others completed during the. This till contains disconnected NAPL lenses, as observed at both MW-116DS and MW-135; this NAPL is not continuous with NZ-2 or NZ-5 (Section 4.1.3).</p> <p>Shoreline NAPL at NZ-2 and NZ-5 NAPL is connected, confirmed through drilling activities at MW-134 and MW-135 (Section 4.1.3).</p> <p>NAPL distribution near the bulkhead suggests that it has accumulated behind the bulkhead and extends beyond the bulkhead to the north and south (Section 4.1.3).</p> <p>NAPL to the north of the Quanta property at NZ-5 is free-phase and characteristically mobile; however, thicknesses of NAPL at NZ-5 are significantly diminished from those at NZ-2. Analysis of the NAPL indicates coal tar and coal tar products. Most NZ-5 NAPL is present at the interface between the fill and soft organic silt units (Section 4.1.3).</p> <p>The southern extent of Site-related NAPL along the shoreline at NZ-2 is now understood; TarGOST® and confirmatory soil borings in the northeastern corner of the former Lever Brothers property have made it possible to define this edge of NZ-2 NAPL (Section 4.1.3).</p>
4. Determine the dimensions of the wooden bulkhead to evaluate its role in limiting NAPL migration	<p>Boards composing the bulkhead penetrate to varying depths, depending upon the subsurface geology present. The depth of the bulkhead on the northern end correlates to the top of the glacial till at that location, and at southern end, the bulkhead truncates at or near the native sand layer, which contains gravel and cobble (Section 3.2.2; Appendix W)</p> <p>Laterally, the wooden bulkhead extends north to the Quanta/former Celotex properties boundary to the southern edge of the 115 River Road building. Below the water table and mean surface water level of the Hudson River, the bulkhead boards are relatively competent; above this, however, near the ground surface, the boards appear weathered (Section 3.2.1; Appendix W).</p> <p>The bulkhead's role as an impediment to groundwater flow towards the west is evidenced by northerly and southerly flow components of groundwater and inland mounding. Strong upward flow gradients are present adjacent to the bulkhead but are less significant to the south, where the bulkhead is not present (Section 3.3.2) and the bedrock and deep sand are at a greater depth.</p> <p>Visual observations of groundwater leakage through the bulkhead at low tide, lower hydraulic heads at select wells adjacent to the bulkhead, and indications of groundwater upwelling detected during the Trident Probe survey suggest a groundwater leakage may be occurring across the structure (Section 3.2.1).</p> <p>The observance of NAPL at the sediment surface of OU2 adjacent to the bulkhead and in near-shore sediments at similar elevations as those immediately adjacent to the bulkhead in OU1 suggest that has not acted as a complete barrier to NAPL migration from OU1 to OU2 (Section 4.1.4).</p>

SRI Objective	Key Conclusions
5. Supplement existing data to sufficiently characterize risk to human health at Block 93 Central and South and for groundwater at the Site as a whole	[Forthcoming.]
6. Begin collection of data to confirm stability of organic constituents and arsenic in groundwater at OU1	<p>Graphs of concentration vs. time for naphthalene, benzene, and arsenic in groundwater showed that concentrations appeared to be stable or decreasing (Section 4.4.1; Section 5.3.5).</p> <p>Mann-Kendall results for benzene and naphthalene showed no wells with increasing concentration trends. However, statistically significant decreasing trends were present for benzene at MW-B and for naphthalene at MW-103DS and MW-114A (Section 4.4.1).</p> <p>With the exception of increasing trends for arsenic two locations in the northern portion of the Site at the former Celotex property, Mann-Kendall trend tests indicated no statistically significant increasing trends in concentrations have been observed across the Site (Section 5.3.5).</p> <p>Increasing arsenic trends in two wells at the former Celotex property that are likely the result of filling and paving that occurred across this area in 2003 and which has since cut off the flux of atmospheric oxygen to the subsurface in this area (Section 5.3.5).</p> <p>Mann-Kendall results for benzene and naphthalene showed no wells with increasing concentration trends. However, statistically significant decreasing trends were present for benzene at MW-B and for naphthalene at MW-103DS and MW-114A (Section 4.4.1).</p>
7. Confirm distribution and mobility of arsenic in groundwater within and downgradient of suspected source zones at OU1	<p>Two primary flow paths exist for dissolved arsenic in groundwater—the first originates from the HCAA and flows south to near the MW-107 well cluster, where the flow direction becomes more easterly toward the Hudson River. The second flow path originates at the HCAA and flows east toward MW-134 (Section 5.3.4).</p> <p>There is no significant westward groundwater flow component from the HCAA area towards Block 93. Elevated concentrations in arsenic in samples collected from MW-111B are the result of the presence of an additional source area and due to the strong southerly flow component on Block 93, arsenic attenuation is occurring quickly here (Section 3.3.1; Section 5.3.4).</p> <p>Key mechanisms resulting in arsenic solubility at the Site are the following:</p> <ul style="list-style-type: none"> • Leaching of acid wastes in two separate areas, the high concentration arsenic area and in the northern portion of the former Lever Brothers property (Section 5.3.1; Section 5.3.4). • Reductive dissolution of iron and arsenic, which occurs along the two primary flow transects. Native organics associated with nearshore deposits and/or the presence of NAPL has caused localized reducing environments (Section 5.3.1; Section 5.3.4). • Competition for adsorption sites with orthophosphates (Section 5.3.1; Section 5.3.4). <p>Four distinct arsenic source areas have been identified and delineated. The HCAA is associated with soils containing pyritic ore; a second location exhibiting an acid leaching signature is located in the northern portion of the former Lever Brothers property, and there are two areas where reductive dissolution of fill constituents results in elevated arsenic concentrations (Section 5.3.2).</p>

SRI Objective	Key Conclusions
	<p>Other sources of arsenic to groundwater exist beyond the extents of OU1 at the former Lever Brothers property (Section 5.3.2).</p> <p>The mobility of arsenic at the Site controlled by several factors including source strength, changes in geochemical conditions, the affinity for arsenic to be adsorbed, and the availability of adsorption sites (Section 5.3.4).</p> <p>Despite orthophosphate competition, attenuation of arsenic is occurring downgradient of both pyritic source areas and areas of reductive dissolution through adsorption on iron oxyhydroxides and soluble arsenic associated with these sources is not reaching OU2 (Section 5.3.4).</p>
<p>8. Characterize groundwater flow paths and distribution and fate and transport of coal tar constituents (VOCs and PAHS) and arsenic across the GW/SW transition zone(s) between OU1 and OU2</p>	<p>The wooden bulkhead along the shoreline acts to impede groundwater flow from OU1 to OU2 and groundwater flowing eastward towards the bulkhead flanks it to the north and south once it reaches the shoreline (Section 3.3.2).</p> <p>Visual observations of groundwater leakage through the bulkhead at low tide, lower hydraulic heads at select wells adjacent to the bulkhead, and indications of groundwater upwelling detected during the Trident Probe survey suggest a groundwater convergence where flow may be occurring across the structure (Section 3.2.1; Section 3.3.2; Section 3.3.3).</p> <p>Areas of potential groundwater upwelling were identified north of and adjacent to the bulkhead along the shoreline. A larger area of upwelling is observed south of 115 River Road, south of the bulkhead's southernmost extent (Section 3.3.3).</p> <p>At OU2, organic constituents and arsenic have been detected in shallow pore water where groundwater-upwelling zones were identified in the nearshore area; samples collected from upwelling zones farther from shore contained very low or non-detectable concentrations of these constituents. Concentrations of these constituents in pore water in the nearshore area also include contributions from NAPL and adsorbed NAPL constituents in the sediment at OU2 (Section 4.4.2; Section 5.3.4; Section 5.3.6).</p> <p>Dissolved arsenic was detected in pore water collected from the three upwelling locations nearest the shoreline. Arsenic concentrations observed in pore water are largely due to partitioning of arsenic from the sediments into the interstitial pore water. The one exception to this is north of the bulkhead, where upgradient groundwater concentrations and hydraulic data indicate that soluble arsenic associated with shoreline fill at OU1 may be contributing to observed arsenic levels (Section 5.3.4; Section 5.3.6), albeit at a significantly reduced concentration below surface water screening criteria.</p> <p>Surface water samples collected at these nearshore areas show an absence of arsenic and only low levels of organic constituents; organic constituents and arsenic were not detected farther from the shoreline (Section 4.4.2; Section 5.3.4; Section 5.3.6). The area affected by potential discharge of dissolved phase organic constituents from groundwater to surface water is limited to nearshore areas adjacent to and flanking the wooden bulkhead (Section 4.4.2). Concentrations of arsenic in the surface water of OU2 were below detection limits, suggesting that a measurable flux of arsenic to the surface water of the Hudson River is not occurring (Section 5.3.6).</p>

The former Celotex property is north of the Quanta property where the site of the General Chemical Company operated on the southern portion of the former Celotex property from at least 1900 until 1957. The chemical plant was used to produce acids, alums, sodium compounds, and sulfuric acid (Parsons, 2005)

8.2 Site Geology and Hydrogeology

Soil impacted by former Site operations consists predominantly of fill material and deposits of native sand, peat, and organic silt in contact with shallow groundwater. With the exception of areas to the north, where a bedrock high is present, these units are underlain by a silty-clay confining layer that ranges in thickness from 2 to 35 feet and is located between 7 and 80 feet bgs. South of the bedrock high, a confined water-bearing “deep sand” unit lies between the aquitard (confining unit) and the bedrock or glacial till surfaces. This deeper sand unit ranges from 7 to 32 feet thick and slopes downward to the south and east away from the bedrock high. There are three major hydrostratigraphic units at the Site; the shallow unconfined aquifer and the deeper confined aquifer are the two water-bearing units, the third is the silty clay aquitard that separates them.

The direction of the shallow unconfined groundwater flow is generally east and south, with an area of radial flow on the Quanta property. Flow direction remains consistent between daily low and high tides; however, the hydraulic gradient is slightly steeper during low-tide conditions. A tidal response has been observed in monitoring wells adjacent to the Hudson River outside the area of the wooden bulkhead, which impedes groundwater flow. At the shoreline, leakage has been observed to occur across the bulkhead during low tide; however, groundwater flow paths suggest most groundwater here is flanking the bulkhead to the north and south before moving into the sediments at OU2 and eventually upwelling to the surface water at OU2 in zones of preferential discharge that have been identified.

The radial groundwater flow pattern in the shallow unconfined groundwater is the result of localized mounding due to recharge associated with low-lying unpaved areas in the central portion of the Quanta property where the presence of less-permeable peat deposits slow the percolation of rainwater. The wooden bulkhead and the bedrock high at the former Celotex property are significant impediments that also drive a more southerly component of flow.

Consistent with previous studies, a zone of groundwater convergence has been observed near the central to northern portion of the former Lever Brothers property, south of the Quanta property. In this area, shallow unconfined groundwater from the central portions of the former Lever Brothers property flows northeast and converges with groundwater flowing southeast from Blocks 93 North, Central, and South and central portions the Quanta property.

Groundwater within the deep sand hydrostratigraphic unit flows uniformly east-southeast as it follows the slope of these deposits unit. Groundwater elevations in the deep sand hydrostratigraphic unit are influenced more readily by tidal conditions than are those in the shallow hydrostratigraphic unit. In the deep sand unit, hydraulic heads are consistently higher than those observed in collocated wells screened at the base of the unconfined shallow groundwater zone. The vertical hydraulic gradients measured between the unconfined and deep sand units remain upward during high- and low-tide conditions and

confirm that the two units are not connected hydraulically and thus have not been impacted by historic Site operations.

8.3 Sources

Sources of Site-related constituents have been identified and characterized. Primary sources are no longer present, except for buried piping on the Quanta property. These sources were associated with coal tar processing from approximately 1872 to 1971 and, subsequently, from oil-recycling operations until 1981. Because of historical activities, secondary sources remain at the Site in the form of NAPL, solid tar, and soil containing PAHs, non-PAH SVOCs, aromatic VOCs, and other constituents. Separate operations at the former acid plant that occurred on and adjacent to the current Quanta property have also resulted in the presence of unburned or partially burned pyrite ore that represent a secondary source of inorganic constituents in soil, particularly arsenic (HCAA).

The preferential pathways evaluation demonstrated that although pipes of various sizes and various construction materials exist in the subsurface at OU1, none of the pipes investigated is acting as a preferential pathway for the migration of NAPL or other COCs beyond OU1. No evidence of a discharge pipe or drain associated with the oil-water separator as described in the Removal Site Investigation (RSI) (GeoSyntec, 2000) was observed in preferential pathways excavation P-1 or P-2, which were located where the former oil water separator pipeline was depicted in Figure 2-5 of the RSI.

Evidence of an oil-water separator outfall pipe was observed during inspections of the wooden bulkhead conducted during the SRI. This consisted of approximately 15 feet of 6-inch-diameter steel pipe that penetrates the wooden bulkhead at the northeast corner of the Quanta property and runs beneath the overhanging concrete pier eastward before terminating as an open-ended pipe approximately 5 feet west of the edge of the concrete overhang. This pipe was dry, and no evidence of groundwater or other liquids were observed to be moving around its exterior at its interface with the bulkhead.

Additional secondary sources of groundwater or soil constituents unrelated to historical operations associated with OU1 or the former acid plant operations but that are found within the lateral extent of OU1 include:

- LNAPL and petroleum impacts in the northeast corner of the former Lever Brothers property
- A small area of pyritic material with elevated concentrations of arsenic, iron, sulfate and other inorganics within the fill in the northern portion of the former Lever Brothers property
- Metals and PAHs in soil and groundwater associated with the heterogeneous fill and to a lesser extent, former rail lines;
- An unidentified upgradient source of chlorinated solvents to shallow upgradient groundwater and deep sand groundwater beneath the Site; and
- PCBs in soil shallow soil on adjacent properties.

8.4 Nature and Extent

To develop a comprehensive understanding of the nature and extent of Site-related constituents and to define the boundaries of OU1, this the RI and SRI Reports have compiled approximately 3,980 soil analyses and data from 72 groundwater-monitoring locations, NAPL fingerprinting and physical characteristics data, TarGOST® coal-tar delineation results, and soil vapor analyses, including, as well as indoor/outdoor air analyses and building surveys.

Additional data were also collected at and downgradient of the shoreline to determine the role of the wooden bulkhead and the movement and distribution of Site-related constituents relative to OU2. Specifically, a groundwater-surface water interaction study was conducted at OU2 that involved the identification of preferential upwelling zones and subsequent sampling of pore water and surface water. Geophysical survey data were collected to determine the depth and breadth of the wooden bulkhead, and five sets of nested piezometers were installed for the collection of hydraulic head data and additional deeper pore water sampling.

Based on the comprehensive RI and SRI dataset, the extent of NAPL was defined, and specific constituents exceeding EPA and state screening criteria were developed for soil and groundwater to identify, and evaluate the nature and extent of constituents.

The location, nature, and extent of free and residual NAPL at OU1 have been characterized using analytical data and field observations and refined using TarGOST®. The extent of solid tar has been defined using field observations. Residual and free-phase NAPL occurs in shallow soils in discrete areas above and on top of the silty-clay confining layer that generally correspond with locations of former primary sources (e.g. historic tank farms). Impacts extend beyond the lateral extent of NAPL in the form of staining or odors, and as adsorbed and dissolved phase aromatic VOCs and PAHs in soil and groundwater.

8.4.1 Nature and Extent of NAPL and Solid Tar

The revised depictions of free-phase and residual coal tar remains consistent with the locations of former tanks depicted in historical maps (Figure 3-8). Consistent with the findings in the RI, the SRI showed that NAPL is not present as a single, contiguous mass. The deepest extents of NAPL are limited to the soil within and above the silty clay confining unit overlying the deep sand unit, or in the fill, native sand, or organic silt above the bedrock high to the north where silty clay is not present. NAPL has accumulated in natural depressions in the surface of the silty clay confining unit or the surface of the shallower peat deposits to the west, except in those areas where it remains hung up around the water table due to elevated viscosities and interfacial tensions preventing further downward migration.

The bulk of NAPL is found within the current Quanta property. NAPL extends west across River Road and onto the eastern portions of Block 92.01 and Blocks 93 North, Central, and South. Site-related NAPL also extends southward into the northern and central portions of the former Lever Brothers property. To the east, NAPL is found in significant thicknesses adjacent to the wooden bulkhead, from which it appears to have moved laterally to the south and north along this feature in deeper and thinner lenses. South of 115 River Road, along the shoreline, Site-related coal tar and NAPL are residual only and are near non-Site-

related NAPL and constituents in soil associated with historical operations at the former Lever Brothers property. To the north, NAPL along the shoreline has been found to accumulate within monitoring well MW-135 and is considered free phase.

With the exception of LNAPL samples collected from MW-7 on the former Lever Brothers property, samples of NAPL found to accumulate in monitoring wells were identified through chemical analysis as consisting, at least partially, of coal tar. Variances in the physical properties of the NAPL samples suggest that they have varying degrees of mobility in the subsurface under current conditions. With the exception of the NAPL detected to the south at monitoring well MW-107 and to the north along the shoreline at MW-135, the NAPL at OU1 has relatively elevated measured viscosity and interfacial tension, indicating a lower propensity to migrate. These data support field observations that indicated that NAPL at select monitoring wells was “thick” and difficult to penetrate with sampling and measurement devices.

Extensive characterization has revealed that most NAPL at the Site is present in six discrete NAPL zones (NZ-1 through NZ-6), depicted in Figure 3-8. Although the NAPL in each of these zones is composed primarily of coal tar, each has distinctive physical characteristics that play a part in its mobility. NAPL present in areas outside these defined zones is generally characterized as residual NAPL only or thin discontinuous pockets of free-phase NAPL not continuous with the larger NAPL zones.

Solid tar has been observed in several soil borings at the Site, most frequently in the form of a black, soft to stiff, semiplastic to plastic material at discrete depth intervals with a thickness ranging from 0.3 foot to approximately 6 feet. Most solid tar has been observed in the fill deposits at the Quanta property and to the west, at Block 93 North, but solid tar was detected in one boring as far west as Block 94. In general, surficial tar “boils” have been observed in areas that coincide with the solid tar.

8.4.2 Nature and Extent of Constituents in Soil

Constituents detected in soil that exceed EPA or state screening criteria include SVOCs (predominantly PAHs), aromatic VOCs, and metals (e.g., arsenic and lead). Other constituents identified less frequently include chlorinated VOCs, pesticides, and PCBs.

As was consistent with previous soil-sampling events in and around the Site, soil samples collected during RI and SRI activities indicate the presence of PAHs in unsaturated and saturated soil throughout the Site. PAHs were not detected above the screening criteria in soil samples collected from the deep sand unit beneath the silty-clay aquitard. Exceedances of aromatic VOCs, particularly benzene, in unsaturated soils appear to lie within the extent of the historical Site operations, whereas the extent of benzene in saturated soil extends slightly farther south, outside the footprint of former operations, in the direction of groundwater flow.

In general, the distribution of PAHs, aromatic VOCs, and other NAPL-related constituents (e.g., select non-PAH SVOCs) was observed to be coincident with the presence of NAPL. The distribution of metals is consistent with areas of former pyrite roasting associated with the former acid plant. Concentrations of both PAHs and metals unrelated to former Site operations or operations associated with the former acid plant have been observed consistently above screening criteria outside these affected areas because of the ubiquitous

fill material throughout the area and south of OU1 and because of historical operations at the former Lever Brothers property.

The extent of elevated arsenic concentrations in soil near the former acid plant has been defined and does not extend beyond the southwestern portion of the former Celotex property and northwestern corner of the Quanta property. During the SRI, a separate and much smaller area of pyritic material was identified as the source of elevated metals concentrations including lead in the northern central portion of the former Lever Brothers property. Elevated arsenic concentrations in soil outside these two pyritic source zones are associated with isolated hotspots in the heterogeneous fill material that also contain concentrations of PAHs above screening criteria. The highest concentrations of arsenic associated with the fill are found in the southeast corner of Block 92.01 the western edge of Block 93 North and in very shallow soil along eastern portions of Block 93 Central. Beyond the pyritic source zones the extent and distribution of lead in soil has also been defined and is different than that of arsenic. The distribution of lead is more widespread at the former Celotex property.

Pesticides in soil within OU1 represent isolated noncontiguous release scenarios likely the result of the historical use of pesticides. Detected concentrations of PCBs in soil above the EPA RSL of 0.22 mg/kg are found to occur in contiguous areas on the western portion of OU1, in the vicinity where activities associated with the oil-recycling operation took place (e.g., oil centrifuging operations, storage, and unloading). The detected PCB concentrations above the screening criteria occur primarily in the vadose zone; detected PCB concentrations exceeding applicable screening criteria in the saturated zone, deeper soils are limited and are present only in five sample locations in four isolated areas.

8.4.3 Nature and Extent of Constituents in Groundwater

Constituents of interest identified in groundwater consist primarily of SVOCs (predominantly PAHs), aromatic VOCs, metals (e.g., arsenic, iron, and lead), ammonia, and, to a lesser extent, chlorinated VOCs, pesticides, and PCBs. The extent of Site-related constituents in groundwater includes areas on the Quanta property; 115 River Road; the former Lever Brothers property; the former Celotex property; Blocks 93 North, Central, and South; Block 94; and Block 92.01. Additional non-Site-related constituents in groundwater that include PAHs, VOCs, and metals are present beyond OU1, in the northeast corner of the former Lever Brothers property and farther south at this property beyond the zone of groundwater convergence.

Naphthalene and benzo(a)pyrene were selected as representative PAHs at OU1. Naphthalene in groundwater extends farther downgradient from known areas of NAPL than the extent of benzo(a)pyrene. In general, naphthalene in groundwater covers an area similar in shape to the portion of the Site in which evidence of NAPL has been identified (except where offsite sources of naphthalene are present). Similarly, the extent of dissolved-phase benzo(a)pyrene is limited to within the total lateral extent of NAPL – again, with the exception of areas where offsite sources are present.

With the exception of naphthalene and benzo(a)anthracene, PAHs were not detected above applicable screening criteria in any groundwater samples collected from monitoring wells screened in the deep sand unit, indicating that most dissolved-phase PAHs are confined to the

shallow fill and native sand deposits above the silty-clay aquitard. The extent of non-PAH SVOCs at OU1 are similar to the extent of PAHs.

Non-PAH SVOCs at OU1 consist primarily of phenolics (e.g., phenol, 2,4-dimethylphenol), dibenzofuran, and carbazole. Non-PAH SVOCs exceeded the applicable groundwater-screening criteria in a lower percentage of RI groundwater samples than PAHs and are found primarily in the central portions of the Site. Non-PAH SVOCs do not extend beyond the footprint of the naphthalene plume.

The distribution of benzene, a representative aromatic VOC, in groundwater is consistent with the known distribution of Site-related NAPL. However, with a greater solubility in groundwater and a lower screening criterion, benzene exceedances in groundwater extend farther hydraulically downgradient of NAPL sources than naphthalene. The footprints of other Site-related VOCs in groundwater at OU1 are within the lateral extent of benzene.

Chlorinated VOCs were detected at their highest concentrations in the deep sand groundwater and in shallow groundwater upgradient of Site-related constituents in groundwater (e.g., aromatic VOCs, PAHs, and non-PAH SVOCs) at the foot of the palisades. The lateral and vertical distribution of these compounds throughout the Site, as well as the relationship of hydraulic heads between the shallow unconfined and deep sand units, indicates that the source of these chlorinated VOC impacts is not the result of a release or releases related to Site-specific historical operations.

Four separate sources of soluble arsenic to groundwater, and to a lesser extent, other inorganic constituents in groundwater have been identified within the lateral extents of OU1 (HCAA, ASA-1, ASA-2, and ASA-3). At the HCAA and ASA-1, elevated concentrations of metals including arsenic have resulted from the leaching of pyritic wastes. Other arsenic sources to groundwater at OU1 (ASA-2 and ASA-3) are the result of the elevated arsenic in fill material in proximity to reducing groundwater conditions that have been caused by the presence of native organic material in the fill as well as NAPL. Groundwater in these reductive source zones has significantly lower concentrations of iron and sulfate, which are components of pyritic wastes. In all areas where elevated concentrations of soluble arsenic have been observed, orthophosphates, which have resulted the presence of phosphorous in coal tar, are playing a significant role in keeping arsenic in solution as they compete with the available iron oxyhydroxide adsorption sites crucial for the attenuation of arsenic in groundwater.

Due to differences in the nature and extent of the pyritic sources versus those of the regional fill material, and because lead, unlike arsenic, is not redox sensitive and is expected to be relatively immobile at the Site, the distribution of dissolved lead in groundwater is distinctly different than that of arsenic and iron. Thus, the portions of the Site where dissolved lead concentrations are greater than the NJGWQS of 5 µg/L are almost exclusively within the footprint the former acid plant. This is due to the specific geochemical environment found here because of the acid generation caused by the leaching of the pyritic material and the relative strength of the HCAA source term compared to other areas.

Concentrations of ammonia, a byproduct of coal tar distillation, that exceed the groundwater-screening criterion do not extend downgradient as far as the Hudson River. The distribution of ammonia concentrations observed in groundwater is consistent with the

location of previous storage areas as identified in historical maps, suggesting the source of these detected constituents is related to the former coal tar operations.

Groundwater sampling results indicate low concentrations of pesticides within the interior of the Quanta property. These are isolated, noncontiguous groundwater concentrations the result of the historical use of pesticides. The PCB Aroclor 1260 was detected at one location in the central portion of the Celotex property (MW-J) during RI groundwater-sampling activities. Because PCBs adsorb strongly to soils and have not been detected in groundwater between the Quanta property and MW-J, this observed concentration is not considered related to Site operations.

At OU2, organic constituents and arsenic have been detected in shallow pore water where groundwater-upwelling zones were identified in the nearshore area; samples collected from upwelling zones farther from shore contained very low or non-detectable concentrations of these constituents. Surface water samples collected at these nearshore areas show an absence of arsenic and only low levels of organic constituents. Concentrations of site-related constituents in the surface water of OU2 were below detection limits, suggesting that measurable discharge of site-related constituents to surface water is not occurring at groundwater-upwelling zones identified farther from the shoreline.

8.4.4 Extent of OU1

The extent of OU1 has been defined and is shown in Figure 8-1. OU1 includes the observed extent of Site-related NAPL and constituents detected in soil and groundwater related to former operations. The lateral extent of OU1 also includes the HCAA.¹ The northern boundary of OU1 is defined by the extent of Site-related NAPL and constituents exceeding EPA and state screening criteria in subsurface soils and groundwater, as well as by the HCAA. The southern boundary of OU1 is the extent of dissolved-phase, Site-related constituents and the groundwater convergence zone in the northern portion of the former Lever Brothers property. To the west, the OU1 boundary is the extent of Site-related NAPL and constituents exceeding EPA or state screening levels in soil and groundwater on Block 93 and soil on a portion of Block 94. The eastern boundary of OU1 is administratively defined as the wooden bulkhead on the Quanta property and portions of the shoreline north and south of the bulkhead.

The vertical extent of Site-related constituents at OU1 generally extends from the ground surface to a maximum depth of the top of the silty-clay confining unit. However, shallow soil (0 to 2 feet bgs) in several areas within the horizontal extent of OU1 does not contain Site-related constituents; these areas include the following:

- Soil currently within the interval of 0 to 2 feet bgs on the Celotex property is above the water table and consists entirely of fill material imported during recent property redevelopment.

¹ The HCAA is generally defined by the extent of reddish-purple soils within the footprint of the former acid plant. On the former Celotex property the extent of the HCAA has been established as the extent of the impermeable arsenic liner, which was designed and built to include concentrations of arsenic in soil in excess of 1,000 mg/kg. The extent of the HCAA at the Quanta property and directly west is based on the historical investigations performed at this property as well as more recent RI and SRI soil investigations and includes visual observations of reddish purple soils and/or locations where analytical data shows concentrations of arsenic in soil are in excess of 1,000 mg/kg.

- Soil within the range of 0 to 2 feet bgs on the former Lever Brothers property and the Block 93 South property is above the water table and does not contain Site-related constituents; buildings and other surface improvements on these properties associated with historical operations would have physically prevented the migration of surface soil from the Site to these properties.
- Limited detections of constituents in soil identified within range of 0 to 2 feet bgs on the Block 93 Central property are most likely a result of rail activity and loading and unloading associated with former Spencer-Kellogg operations. However, minor erosion may have resulted in incidental transport of Site-related constituents to Block 93 South.
- Soil within the range of 0 to 2 feet bgs within the footprint of River and Gorge Roads is above the water table and consists of fill material imported during road construction in the 1990s.

8.5 Fate and Transport

Relevant fate and transport processes controlling the migration of constituents at the Site have been evaluated and are understood sufficiently to allow development of remedial alternatives.

8.5.1 Fate and Transport of NAPL

The potential for migration of NAPL varies among the six discrete NAPL zones on the basis of the varying physical characteristics (e.g., viscosities, densities, and interfacial tensions) of NAPL samples collected across these areas as well as the physical characteristics of the subsurface. NAPL migration under current conditions has been evaluated for each of the NAPL zones (shown in Figure 3-8):

- **NZ-1.** High viscosity and interfacial tension have generally limited the downward vertical migration of NAPL to a maximum depth of 11 feet bgs. At an isolated area (the vicinity of MW-102B and SB-9), NAPL has migrated to the depth of the silty-clay confining unit, approximately 23.5 feet bgs. Historical Sanborn maps and a greater thickness of fill indicate that disturbances of subsurface soils likely occurred here during the removal of a former UST, which resulted in the presence of localized deeper NAPL here. Further migration of NAPL in this zone is not predicted to occur, based on the physical characteristics of the NAPL and the likely age of the release(s) that resulted in the presence of NAPL here. At localized area of deeper NAPL down to 23.5 feet bgs exists beneath NZ-1 because of a former UST that was located here; its further migration is prevented by the presence of the silty-clay confining unit.
- **NZ-2.** NAPL viscosities span a wide range, and thicknesses measured in several wells indicate elevated NAPL saturation levels. These factors, along with the dip of stratigraphic units eastward, suggest that at least a portion of the NAPL at NZ-2 is characteristically mobile. The bulkhead along the shoreline extends below the base of all observed NAPL at NZ-2 and is a significant impediment to NAPL migration; however, it is not a complete barrier. The presence of NAPL in nearshore sediment and at similar elevations in OU1 and OU2 are evidence that NAPL has moved and may continue to move from OU1 to OU2. NAPL has also flanked the bulkhead towards the north and

south, with more mobile forms migrating towards NZ-5 in the north, where heavy sheening is observed along the shoreline. To the south, NZ-2 NAPL is residual and currently immobile, as indicated by the absence of measurable thickness in wells screened across NZ-2 in this area.

- **NZ-3.** NZ-3 consists of deeper NAPL in the central portion of the Quanta property, extending across the 115 River Road property onto the northern portion of the former Lever Brothers property. NAPL in NZ-3 has migrated downward and laterally to a natural depression in the top of the silty-clay confining unit at approximately 25 feet bgs. Gravitational forces and the impermeability of the confining layer prevent further downward and lateral migration of NAPL in this zone. However, historic geotechnical borings completed in the northern portion of the former Lever Brothers property indicate that the silty-clay unit dips south and east beyond where NAPL is present as thin and discontinuous lenses. If additional migration were to occur, it would follow the silty-clay surface to depths of at least 75 feet bgs, where it would have no potential to migrate to surface water or sediments associated with the Hudson River.
- **NZ-4.** NZ-4 comprises deeper NAPL beneath Blocks 93 Central and South, River Road, and the northwestern portion of the former Lever Brothers property located between 9.5 and 17.5 feet bgs. Potential migration of NAPL in NZ-4 is unlikely due to elevated viscosity and interfacial tension. The peat and depression in the silty-clay surfaces in the area provide a barrier to further vertical and lateral migration.
- **NZ-5.** NAPL was identified in borings and by TarGOST® adjacent to the Hudson River between 18 and 25 feet bgs. Although it is present in reduced thicknesses compared to the NAPL at NZ-2 to the south, it has been found to accumulate in monitoring well MW-135. The downward-sloping contact between the fill material and the underlying organic silt as well as the physical properties of NAPL suggest that portions of NZ-5 NAPL are characteristically mobile. The absence of the wooden bulkhead and the presence of NAPL at similar elevations in sediment at adjacent nearshore areas of OU2, in addition to the consistent presence of sheens in these areas, also suggest that NZ-5 NAPL should be considered mobile.
- **NZ-6.** NAPL was observed in borings completed within in the intersection of Gorge and River Roads just below the water table at depths ranging from 8 to 15 feet bgs. Its inability to accumulate in MW-126 and MW-N-2 has not allowed for a determination of its physical characteristics but suggest that NAPL saturation levels here are lower than those observed at other NAPL zones. Thin stringers of NAPL may connect NZ-6 to portions of NZ-1 in the northwest corner of the Quanta property, but due to the raised elevation of River Road and Block 92.01, it resides at a greater depth below grade and the lateral extent is limited to the footprint of the former tank farm in this area, therefore NZ-6 is being considered separately from NZ-1. The vertical extent of NZ-6 is limited to the interface of the fill and underlying native sand and peat deposits. If further vertical migration of NZ-6 were to occur, it would be physically contained by natural depressions in the silty-clay surface.

8.5.2 Fate and Transport of Constituents in Soil

Two major mechanisms exist for the transport of constituents in soil at the Site: leaching and volatilization. Erosion, degradation, and bioaccumulation play less-significant roles in the transport of constituents in soil at the Site.

Although SVOCs (including PAHs) at OU1 generally adsorb strongly to soil particles and do not leach significantly, characteristics of the sources (i.e., NAPL) present in the subsurface and the length of time they have been present have resulted in the dissolution of SVOCs into groundwater over the Site at levels exceeding applicable screening criteria. Since Site-related constituents have been in place for the past 25 to 130 years, it is assumed that most of the volatilization of these constituents has already taken place and that significant volatilization of SVOCs from surface soil is unlikely unless surface soil is disturbed.

Aromatic VOCs at the Site, such as benzene, have leached from the soil to the groundwater. Benzene has a low affinity for adsorption; therefore, leaching has resulted in a large area of benzene in the saturated zone, compared to a relatively small area of benzene in the unsaturated zone. The potential for constituents to volatilize from both soil and groundwater and enter into the indoor air of structures has been evaluated extensively and is addressed in the HHRA.

Elevated metals, specifically arsenic in Site groundwater, are present in four distinct areas. Two of these areas (HCAA and ASA-1) are composed of pyritic waste material; the other two (ASA-2 and ASA-3) are hot spots within the heterogeneous and ubiquitous fill that was used to initially raise the topographic elevation along the banks of the Hudson River. Mobilization of arsenic from pyritic source zones is due to the leaching of these acid wastes, whereas reductive dissolution resulting from the increased presence of dissolved organics has led to soluble arsenic near hot spots within the fill.

A distinct mineralogical difference exists between the brown-black fill and the reddish-purple soils within the footprint of the former acid plant (HCAA). Mineralogical assessments performed on soils at ASA-1 indicated a mineralogical signature different than that of HCAA, with only very trace amounts of pyrite; however, the characteristics of the groundwater near ASA-1 suggest a separate and weaker source of pyritic material also exists here.

The oxidation of these pyritic wastes because of their exposure to oxygenated rainwater and groundwater ultimately produces reddish iron oxide minerals and elevated concentrations of iron and sulfate along with metal impurities of the ore, such as arsenic, lead, copper, antimony, and thallium. In the slag-rich fill, the transport of metals in unsaturated soils is controlled by the adsorption and desorption of these metals to and from soil during the infiltration of rainwater.

Within the saturated zone, desorption of arsenic in hot spot areas is promoted by the presence of sources of organics, including NAPL, organic-rich fill, and the native peat and organic silt deposits. This is causing the reductive dissolution of iron oxyhydroxides which serve as adsorption sites for arsenic.

Pesticides and PCBs are present in limited areas of OU1 and adsorb strongly to soil particles, limiting their downward migration and transport in groundwater.

Significant additional migration of constituents in soil at OU1 is not expected to occur. Dissolved phase constituents are at equilibrium with all of the sources, including NAPL. Limited infiltration and surface improvements prevent volatilization, erosion, leaching, or degradation from becoming significant transport mechanisms for constituents in unsaturated soil.

8.5.3 Fate and Transport of Constituents in Groundwater

Adsorption and degradation reactions are the most dominant attenuation factors for the fate of groundwater constituents at the Site.

A number of primary lines of evidence suggest that the attenuation of both the organic constituents and arsenic is occurring within and downgradient of OU1. In general, time versus concentration plots and Mann-Kendall statistical trend analyses show that the composite extent of both the organic constituents and arsenic in groundwater is not currently expanding beyond their current boundaries. The more mobile dissolved-phase constituents in groundwater (benzene and naphthalene) have not migrated hydraulically downgradient beyond approximately 175 feet of the defined extents of Site-related NAPL. Mann-Kendall trend tests performed on arsenic time-series data indicate that no statistically significant upwards trends in arsenic concentrations are occurring at OU1 with the exception of one area at the former Celotex property that showed an increasing trend in two wells since sampling began in 2003. These increases are likely the result of filling and paving that occurred across this area in 2003 and which has since cut off the flux of atmospheric oxygen to the subsurface in this area. Similarly, seasonal changes in redox conditions and the kinetics of redox reactions involving arsenic can result in short-term fluctuations in arsenic concentrations measured at each well. These ephemeral changes do not indicate that arsenic is being advectively transported in groundwater, but emphasize the importance of a balanced statistical approach to evaluating arsenic plume stability. Time versus concentration plots and Mann-Kendall trend evaluations will continue to be updated for both organic constituents and arsenic as new data become available.

Specialty soil and groundwater analyses and further characterization of the geochemical context have resulted in lines of evidence that support a detailed understanding of the mechanisms affecting the behavior of arsenic in groundwater at the Site. The solubility of arsenic is controlled by a combination of variables, including pH, redox conditions (as measured by Eh), iron oxide state and content, cation exchange capacity, major ion chemistry, and the organic content of the soil. Redox conditions at the Site are controlled by the Site-wide sources of organics, including organic-rich fill, native peat, and organic silt, as well as NAPL and locally by oxidizing pyrite. Levels of arsenic measured in groundwater are directly proportional to concentrations of total phosphorous, indicating that orthophosphates in groundwater are playing a significant role in limiting arsenic attenuation because they compete with arsenic for adsorption sites, causing arsenic to remain in solution. Despite the presence of orthophosphate and the dominance of the more mobile arsenite species in areas of elevated arsenic concentrations, an evaluation of these data along key groundwater flow transects support that the attenuation of arsenic through adsorption is occurring at the Site.

Arsenic near the former acid plant attenuates in groundwater along two distinct flow paths (to the south and to the east) through adsorption prior to reaching the Hudson River.

Similarly, soluble arsenic associated with a separate and much smaller area of pyritic material at the former Lever Brothers property unrelated to the former acid plant also attenuates before reaching the Hudson River. Additional sources of arsenic related to fill in groundwater conditions that are highly reducing have contributed to the presence of dissolved-phase arsenic concentrations adjacent to the Hudson River north and south of the Quanta property. Groundwater and hydraulic head data suggest that NAPL adjacent to and north and south of the bulkhead is a source of dissolved phase organics to the pore water at OU2; however, additional sources of Site-related NAPL constituents and arsenic are present within the sediments at OU2.

Groundwater migration from OU1 towards OU2 is impeded by the bulkhead along the shoreline, but groundwater eventually moves into OU2 as it flanks this structure to the north and south and moves through areas of observed leakage. Preferential discharge zones for groundwater have been identified at OU2 through a Trident probe study. Despite the presence of additional near-shore sources, concentrations of dissolved-phase NAPL and coal tar constituents in shallow pore water and surface water at these zones of preferential upwelling zones are significantly reduced because of attenuation. With the exception of groundwater upwelling zone sampled north of the bulkhead, the SRI data suggest that concentrations of arsenic observed in pore water are a function of the arsenic within the sediment and redox conditions in proximity to nearshore NAPL sources at OU2. Upgradient groundwater data, in conjunction with hydraulic data, indicate that the low-level concentrations of arsenic in the pore water north of the bulkhead may in part be the result of the advective transport of soluble arsenic in nearshore groundwater that is two orders of magnitude higher and that is the result of the reductive dissolution of arsenic in the fill here. The area affected by potential contaminant discharge from groundwater to surface water is limited to nearshore areas adjacent to and flanking the wooden bulkhead.

In general, lead is strongly adsorbed under a wide range of pH and Eh conditions and would not be transported readily in groundwater. Due to the relative immobility of lead, elevated concentrations of lead in groundwater associated with the HCAA do not persist in groundwater downgradient to the south or east of the source because lead is adsorbed quickly to organics or hydroxide minerals, or it is precipitated. Lead associated with the former acid plant attenuates in groundwater through adsorption and does not migrate to the Hudson River.

The random and isolated occurrences of pesticides in groundwater, as well as their chemical characteristics, indicate that pesticides are not mobile in groundwater at the Site. PCBs were detected in groundwater in one location, the central portion of the former Celotex property, and are unrelated to former Site operations. As with pesticides, the characteristics of PCBs and the isolated occurrence in groundwater indicate that PCBs are not transported in groundwater.

Ammonia in OU1 groundwater does not discharge to the Hudson River. Although ammonia is present at concentrations above screening levels, adsorption and microbial activity act to attenuate the impacts such that concentrations in groundwater adjacent to the Hudson River are below the screening criterion.

8.6 Risk Assessment

This section is incomplete and is under a separate track since the HHRA for Block 93 Central and South needs to be completed. [Revisions Forthcoming].

An HHRA was conducted for most of OU1 (with the exception of River and Gorge Roads, and Blocks 93 Central and South) and has identified COCs for three media:

- Surface soil (0 to 2 feet bgs)
- Subsurface soil (0 to 10 feet bgs)
- Groundwater (above and below the silty-clay confining layer)

Existing potential receptors identified in the HHRA include trespassers, commercial workers, and daycare children. For potential future land use, receptors include construction/utility workers, commercial workers, daycare children, trespassers, and residents. Risks above acceptable levels for one or more existing or future receptors because of exposure to soil or groundwater were calculated on all properties evaluated. The primary risk drivers at the Site are carcinogenic PAHs, naphthalene, and arsenic. These primary risk drivers, along with surficial tar boils identified during the RI, will be addressed during future remedial actions.

Studies of potential vapor intrusion pathways have been conducted at buildings at 115 River Road, Block 93 North (former Jono's Restaurant), and the former Lever Brothers property (Building 9). These studies have included groundwater, subslab, and indoor air sampling; physical observations of the buildings; and measurements of air pressure within the buildings. The results from these studies conclude that vapor intrusion pathways are unlikely to be present or are of a magnitude sufficiently small as to not pose an unacceptable human health risk to the occupants of these buildings under current conditions.

A Screening Level Ecological Risk Assessment (SLERA) completed for OU1 evaluated potential risk to terrestrial receptors from exposure to compounds detected in surface soil on the 5.5-acre Quanta property. Potential ecological risk was evaluated through direct exposure to soil and via the food-chain exposure pathway. Using conservative exposure scenarios and assumptions, risk was indicated to plant and invertebrate receptors via direct exposure and to higher-order receptors exposed to contamination through the food chain. The SLERA was refined using less-conservative assumptions, which reduced the number of compounds indicating potential risk from direct exposure and limited the higher-order receptors at potential risk to small mammal species. Based on the location of the Site in an urban area with limited and poor quality habitat available for receptor populations, inhabitation of OU1 by these receptors is unlikely. In the July 7, 2006, comments on the SLERA, EPA agreed with the overall conclusion that additional characterization of ecological risk at OU1 was not necessary.

SECTION 9

References

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TABLE 2-1

Summary of Soil Boring Information
Quanta Resources Superfund Site, OU1
Edgewater, New Jersey

Boring ID	Completion Date	Northing	Easting	Ground Elevation (ft. msl)	Property	Total Depth (ft. bgs)	Logged Interval (ft. bgs)	Method
Boring Locations At Which Soil Logging Was Performed								
BH-1	9/17/2008	718555.52	633638.32	5.9	Quanta	41.5	0-41.5	Rotasonic
BH-2	9/18/2008	718463.72	633605.07	5.8	Quanta	55	0-55	Rotasonic
SB-39	2/24/2009	718919.42	632411.38	9.9	Block 94	24	0-24	Direct-push Geoprobe
SB-40	8/26/2008	718936.46	632632.33	5.4	Block 93 Central	25	0-25	Direct-push Geoprobe
SB-42	8/26/2008	718855.95	632552.85	5.5	Block 93 Central	20	0-20	Direct-push Geoprobe
SB-43	8/26/2008	718888.48	632452.28	6.3	Block 93 Central	20	0-20	Direct-push Geoprobe
SB-44	9/4/2008	718794.96	632515.61	5.8	Block 93 Central	25	0-25	Direct-push Geoprobe
SB-47	8/27/2008	718695.85	632433.91	7.4	Block 93 South	20	0-20	Direct-push Geoprobe
SB-48	8/27/2008	718501.54	632419.00	8.3	Block 93 South	25	0-25	Direct-push Geoprobe
SB-49	9/2/2008	719087.66	632980.70	12.1	Gorge/River Rd	30	0-30	Direct-push Geoprobe
SB-50	10/16/2008	719202.95	632992.23	12.1	Gorge/River Rd	30	0-30	Rotasonic
SB-51	9/2/2008	719209.49	633062.82	11.1	Gorge/River Rd	25	0-25	Direct-push Geoprobe
SB-52	2/24/2009	719312.35	632862.42	14.6	Block 92.01	28	0-28	Direct-push Geoprobe
SB-53	9/5/2008	718997.16	633163.65	7.0	Quanta	20	0-20	Direct-push Geoprobe
SB-54	10/3/2008	719141.86	633070.43	12.4	Former Celotex	25	0-25	Rotasonic
SB-55	10/8/2008	718366.93	632979.26	7.4	Former Lever Brothers	25	0-25	Rotasonic
SB-58	2/25/2009	719329.30	632943.51	16.2	Block 92.01	28	0-28	Direct-push Geoprobe
TL08.5-10.5	8/28/2008	718434.05	632441.45	8.4	Block 93 South	20	0-20	Direct-push Geoprobe
TL09-09	8/29/2008	718391.10	632617.65	7.1	Former Lever Brothers	32.22	0-25	Direct-push Geoprobe/TarGOST
TL09.5-10.5	8/28/2008	718520.92	632507.36	7.2	Block 93 South	30.05	0-25	Direct-push Geoprobe/TarGOST
TL09.5-11.25	8/28/2008	718561.88	632421.17	7.9	Block 93 South	29.92	0-20	Direct-push Geoprobe/TarGOST
TL10-09.5	9/4/2008	718518.19	632610.46	6.7	Former Lever Brothers	30.15	0-30	Direct-push Geoprobe/TarGOST
TL10.5-00	9/4/2008	718085.70	633394.89	5.2	Former Lever Brothers	25	0-25	Direct-push Geoprobe
TL10.5-09.5	8/29/2008	718545.63	632632.22	7.2	Former Lever Brothers	30.05	0-30	Direct-push Geoprobe/TarGOST
TL10.5-10.5	8/27/2008	718610.56	632560.20	6.9	Block 93 South	30.03	0-30	Direct-push Geoprobe/TarGOST
TL10.5-11.25	8/28/2008	718659.50	632477.23	7.8	Block 93 South	30.03	0-20	Direct-push Geoprobe/TarGOST
TL11-11.75	8/27/2008	718722.42	632461.32	7.6	Block 93 South	30.06	0-25	Direct-push Geoprobe/TarGOST
TL11.25-00	9/4/2008	718140.59	633437.44	6.3	Former Lever Brothers	30.03	0-25	Direct-push Geoprobe/TarGOST
TL11.75-00	9/3/2008	718165.95	633472.93	6.5	Former Lever Brothers	31.19	0-25	Direct-push Geoprobe/TarGOST
TL12-00.5	9/3/2008	718217.72	633457.28	7.6	Former Lever Brothers	30.09	0-30	Direct-push Geoprobe/TarGOST
TL12-01.5	8/29/2008	718272.22	633387.18	7.4	Former Lever Brothers	30.05	0-20	Direct-push Geoprobe/TarGOST
TL12.5-00	9/3/2008	718223.08	633504.59	6.6	Former Lever Brothers	23.00	0-22	Direct-push Geoprobe/TarGOST
TL12.5-10.5	8/25/2008	718776.99	632660.05	7.2	Block 93 Central	30.08	0-30	Direct-push Geoprobe/TarGOST
TL13.5-10.5	8/25/2008	718880.28	632704.15	8.3	Block 93 Central	35	0-35	Direct-push Geoprobe/TarGOST
TL13.5-12.75	8/26/2008	718963.75	632475.59	7.0	Block 93 Central	30.00	0-20	Direct-push Geoprobe/TarGOST
TL14-13.25	8/25/2008	719059.36	632514.65	7.2	Block 93 North	30.05	0-20	Direct-push Geoprobe/TarGOST
Boring Locations At Which Only TarGOST Characterization Was Performed								
TL10-09	8/21/2008	718480.75	632649.08	7.5	Former Lever Brothers	30.07	No Log**	TarGOST
TL10-06.5	8/21/2008	718361.78	632855.71	8.2	Former Lever Brothers	30.04	No Log**	TarGOST
TL10-07.5*	8/21/2008	718427.31	632742.32	8.2	Former Lever Brothers	5.37	No Log**	TarGOST
TL10-11.25	8/20/2008	718616.58	632452.62	7.8	Block 93 South	30.06	No Log**	TarGOST
TL11-00*	8/22/2008	718109.36	633414.43	5.2	Former Lever Brothers	11.04	No Log**	TarGOST
TL11-10.5	8/21/2008	718658.87	632570.89	7.6	Block 93 South	30.06	No Log**	TarGOST
TL11-11.25	8/20/2008	718702.28	632492.82	7.7	Block 93 South	30.09	No Log**	TarGOST
TL11.5-10.5	8/21/2008	718688.09	632600.91	7.3	Block 93 South	30.00	No Log**	TarGOST
TL11.5-11.25*	8/20/2008	718738.16	632529.41	7.6	Block 93 South	0	No Log**	TarGOST
TL14-12.25	8/19/2008	719000.42	632577.94	6.4	Block 93 North	30.08	No Log**	TarGOST
TL14.5-11.75	8/19/2008	719022.11	632644.00	6.5	Block 93 North	28.41	No Log**	TarGOST

Notes:

Soil boring summary table does not include soil borings drilled as part of monitoring well installation. Monitoring wells are summarized in Table 2-4

* - Refusal encountered at or near ground surface for locations TL10-07.5, TL11.5-11.25, and TL11-00.

** - No soil logging occurred because location was advanced only for the purposes of collecting TarGOST data.

ft. bgs - Feet below ground surface

ft. msl - Feet referenced to mean sea level, NAVD 88

TABLE 2-2
Correlation of TarGOST® Results with Conventional Data
Quantia Resources Superfund site, OU1
Edgewater, New Jersey

TarGOST® Location	Total TarGOST® Boring Depth	Interval		Max. Signal (%RE)	Depth of Max Signal (ft bgs)	Adjacent and/or Collocated Borings			Description of Tar/ Product Observed	Associated Analytical Soil Results for Select Compounds (mg/kg) ⁵	Comments/Conclusions
		Depth Range	NAPL			NAPL Boring ID ¹	Lithology Boring ID ²	Visual Description(s) ³			
TL09-09	32.2	0-32	No	52.9	19.9	TL09-09	TL09-09	TL09-09 -Fill (gravel, slag, coarse sand) to 15 feet. Very dark brown peat/peaty clay present from 15-23 feet.		TL-09-09 (19.3-20') Total BTEX - ND Total PAHs - ND	Enhanced response from 15 to 20' due to soil matrix (peat).
TL09.5-10.5	30.0	0-30.1	No	55.5	16.6	TL09.5-10.5	TL09.5-10.5	TL09.5-10.5 - Sandy, gravel fill to12.5 feet; product and minor incandescent sheen observed within a coal interval from 12 to 12.5 feet. Very dark brown peat/peaty clay present from 12.5-21.5 feet.		TL-09.5-10.5 (16-17') Total BTEX - ND Total PAHs - 17.11	Enhanced response from 15 to 21 feet due to soil matrix (peat).
TL09.5-11.25	29.9	0-29.0	No	53.5	0.8	TL09.5-11.25	TL09.5-11.25	TL09.5-11.25 - Fill to 10.5 feet (crushed rock, some coal pieces and glass at 0.5-5.0 feet). Peaty clay observed from 10.5 to 12.5 feet.		TL09.5-11.25 (0-1') Total BTEX - ND Total PAHs - 47.4	NAPL absence cofirmed by analytical data and visual observations. Enhanced response from 10.5 to 12.5 feet due to soil matrix (peat).
TL10-07.5	5.4	0-5.4	No	32.6	1.9			This location sampled using TarGOST only and equipment was refused near the surface (5.4 feet). Nearby borings include TL10-09, TL11-07.5, and 10-06.5			Shallow refusal encountered.
TL10-06.5	7.1	0-7.1	No	56.7	4.3			This location sampled using TarGOST only, see TL11-06.5 which is located northeast of target and TL10-05.5, which is located east-southeast of the target.			Shallow refusal prompted second attempt.
TL10-06.5b	30.0	0-30	No	39.7	13.2			See 10-06.5			Enhanced TarGOST repsonse observed between 12 and 14 feet possibly due to soil matrix (peat).
TL10-09.5	30.2	0-6.5	No	148.0	<0.1	TL10-09.5	TL10-09.5, TL10.5-9.5	TL10-09.5 -Slough to 5 feet. Fill (intermixed silty fine sand, fine to medium gravel and slag, some coal, trace brick and cinders) to 11.5 feet			Response potentially due to vegetation or asphalt debris near surface or probe window not having fully penetrated ground surface. Response occurs over an extremely narrow range (0.001 foot). General response for 0-6.5 feet is less than 10%.
		6.5-8.5	Yes	47.5	6.9			TL10-09.5 - Trace product globs, some amber product globs, odor at 6.5-8.5 feet. TL10.5-9.5 - Very slight sheen noted at 7.5 feet within fill material.	Liquid product globs and amber product globs.	TL10-09.5 (6.5-8.5') Total BTEX - ND Total PAHs - 3.75	False negative result; trace NAPL was visually confirmed in both lithological borings.
		8.5-30	No	51.3	19.8			TL10-09.5 - Very dark brown peat/peaty clay present from 11.6-30 feet.			Enhanced response from 11.6 to 30 feet due to soil matrix (peat).
TL10-09	30.1	0-30.1	No	31.9	19.1			This location sampled using TarGOST only, see TL10-09.5 for lithology, which was located west-northwest of target.			Enhanced TarGOST repsonse observed below 15 feet likely to soil matrix (peat), which was present from 11.6 to 30 feet in broing TL10-09.5
TL10.5-10.5	30.0	0-13.4	No	32.1	13.2	TL10.5-10.5	TL10.5-10.5	TL10.5-10.5 - Fill (silty sand, sand, grave, trace brick) to 15 feet. Product, obvious odor, and sheen observed from 13.4-15.5 feet. Very dark brown peat/peaty clay present from 15 to 25 feet; underlain by stiff clay from 25 to 30 feet.			
		13.4-15.9	Yes	131.5	14.2				Liquid product with sheen	TL-10.5-10.5 (14-15') Total BTEX - 237 Total PAHs - 20,028	NAPL confirmed visually and with analytical data.
		15.9-30	No	73.5	15.7						Enhanced response from 15-25 feet due to soil matrix (peat).
TL10.5-09.5	30.1	30.1	No	904.0	0.2	TL10.5-09.5	TL10.5-09.5, TL10-09.5	TL10.5-9.5 - Fill (silty sand, sand, gravel, trace brick, some slag) to 10 feet. Slight petroleum odor noted at between 1.5 and 5 feet. Very dark brown peaty clay from 15 to 20 feet; no recovery from 10 to 15 feet, but material is inferred to be peaty clay. Dark grey peaty clay present from 20 to 30 feet.		TL10.5-9.5 (0-1.5') Total BTEX - ND Total PAHs - 73.68	Enhanced response near surface could potentially be due to vegetation or asphalt debris near surface. Higher responses noted in upper 3 feet with the maxium at 0.2 feet below the surface; response drops rapidly after that.
										TL-10.5-09.5 (23-24') Total BTEX - ND Total PAHs - ND	Enhanced response due to soil matrix (peat) observed below 10 feet.
TL10.5-09.5b	5.1	0-5	No	97.8	<0.01	TL10-09.5	TL10-09.5, TL10.5-9.5, TL10-09	See Lithology for TL10-9.5 and TL10.5-9.5 above.			Response potentially due to vegetation or asphalt debris near surface or probe window not having fully penetrated ground surface. Response occurs over an extremely narrow range (0.001 foot) at ground surface. Response for remainder of boring is generally less than 10%.
TL10.5-11.25	30.0	30.1	No	51.9	12.3	TL10.5-11.25	TL10.5-11.25	TL10.5-11.25 - Fill (crushed concrete, sand, and gravel) to 10.6 feet. Very dark brown peat/peaty clay present from 10.6 to 15 feet; underlain by stiff clay from 15 to 20 feet.		TL-10.5-11.25 (11-12') Total BTEX - ND Total PAHs - ND	Enhanced response due to soil matrix (peat) observed between 10 and 15 feet.
TL10-11.25	30.1	0-30.1	No	47.3	11.8			This location sampled using TarGOST only, see TL10.5-11.25 for lithology, which was located north of target.			Enhanced TarGOST repsonse observed between 10 and 13 feet likely to soil matrix (peat), which was present from 10.6 to 15 feet in broing TL10.5-11.25.
TL11-10.5	30.1	0-14.7	No	40.9	14.4		TL10.5-10.5	TL10.5-10.5 - Fill (silty sand, sand, grave, trace brick) to 15 feet. Product, obvious odor, and sheen observed from 13.4-15.5 feet. Very dark brown peat/peaty clay present from 15 to 25 feet; underlain by stiff clay from 25 to 30 feet.			
		14.7-14.8	Yes	63.6	14.7				Liquid product with sheen	TL-10.5-10.5 (14-15') Total BTEX - 237 Total PAHs - 20,028	NAPL zone at 14.7-14.8 feet indicated by TarGost data
		14.8-30.1	No	77.9	29.4						Enhanced response due to soil matrix (peat) between 15 and 22 feet.
TL11-11.25	30.1	0-30.1	No	87.0	14.0		TL11-11.75, TL10.5-11.25, SB-47	TL10.5-11.25 - Fill (crushed concrete, sand, and gravel) to 10.6 feet. Very dark brown peat/peaty clay present from 10.6 to 15 feet; underlain by stiff clay from 15 to 20 feet.			Enhanced response due to soil matrix (peat) observed between 10 and 15 feet.
TL11-00	11.0	0-30	No	13.3	6.3	TL11.25-00	TL11.25-00, TL10.5-00	TL11.25-00 - Fill (sand, gravel, trace brick and fractured rock) to 14 feet, underlain by organic silt to 25 feet.			No enhanced reponses due to matrix not observed in TarGOST data; dark brown peat/peaty clay absent from boring.
TL11-11.75	31.2	0-30.1	No	129.6	2.8	TL11-11.75	TL11-11.75, SB-47	TL11-11.75 - No recovery from 0 to 10 feet, material observed to be very hard. Very dark brown peaty clay present from 10 to 15 feet; no recovery from 15 to 20 feet. Stiff clay from 20 to 25 feet.		SB-47 (1.0-2.0') Total BTEX - ND Total PAHs - 107	Analytical results do not reflect presence of site-related NAPL, possible asphalt interference.
								SB-47 - Crushed asphalt at 0 to 1 feet. Silty sand, coal, cinder at 1 to 5 feet and peaty clay from 10 to 15 feet		SB-47 (2.7-3.7') Total BTEX - ND Total PAHs - 1.3 TL-11-11.75 (10-12') Total BTEX - ND Total PAHs - 1.0	

TABLE 2-2
Correlation of TarGOST® Results with Conventional Data
Quanta Resources Superfund site, OU1
Edgewater, New Jersey

TarGOST® Location	Total TarGOST® Boring Depth	Interval		Max. Signal (%RE)	Depth of Max Signal (ft bgs)	Adjacent and/or Collocated Borings			Description of Tar/ Product Observed	Associated Analytical Soil Results for Select Compounds (mg/kg) ⁵	Comments/Conclusions
		Depth Range	NAPL			NAPL Boring ID ¹	Lithology Boring ID ²	Visual Description(s) ³			
TL11.5-10.5	30.0	0-9.5	No	36.3	7.8		TL11-10.5, TL12-10.75, MW-123	TL12-10.75 - Fill (silt, coarse gravel, cinder and slag) to 16 feet; from 5 to 10 feet incandescent sheen and obvious product odor observed, and intermittent medium viscosity black product in pore space; product observed between 10 and 15 feet. Very dark brown peat/peaty clay present from 16 to 28 feet; underlain by stiff clay from to bottom of boring.	Pervasive liquid product		
		9.5-15.4	Yes	87.9	13.6			NAPL zone at 9.5-15.4 feet was visually confirmed.			
		15.4-30.0	No	96.4	19.1			MW-123 - Pervasive liquid NAPL from 1.6-15 feet.			Enhanced response from 15 to 28 feet observed due to soil matrix (peat).
TL11.25-00	30.0	0-30	No	133.8	15.6	TL11.25-00	TL11.25-00, TL11.75-00, TL11-00, MW-106A	TL11.25-00 - Fill (sand, gravel, fractured rock, coal pieces, trace brick) to 14 feet. Slight sheen on water noted from 10 to 14 feet. Obvioius odor noted between 13.5 and 14 feet. Fill is underlain by organic silt to 25 feet (bottom of boring), with obvious odor noted between 14 and 15 feet. See Lithology for TL11.75-00 below.		TL-11.25-00 (16.5-18.5) Total BTEX -53.6 Total PAHs- 2.8 Fingerprint - Petrogenic NAPL with kerosene-range hydrocarbons	TarGOST response was likely due to presence and interference of other petroleum product, as evidenced by low PAH and high BTEX concentrations. Response was isolated to the interval were impacts had been visually observed. No enhanced reponses due to soil matrix observed in TarGOST data; dark brown peat/peaty clay absent from boring.
TL11.25-00b	30.0	0-30	No	209.7	16.7	TL11.25-00	TL11.25-00, TL11.75-00, TL11-00, MW-106A	See Lithology for TL11.25-00 above and below for TL11.75-00.			Second boring performed for QA/QC reasons. Elevated TarGOST response present at a very similar depth and is even more distinct and isolated in this second boring, which supports the conclusions listed above.
TL11.75-00	31.2	0-32	No	205.9	13.9	TL11.75-00	MW-106A, TL12-00.5, TL11.25-00, TL11.75-00, MW-120A, MW-106	Also see lithology for TL11.25-00 above. TL11.75-00 - Fill (silty sand, sand, gravel, brick and crushed rock) to 10 feet. Organic silt from 10 to 25 feet (bottom of boring) with trace possible product seams at 10-15 feet (obvious odor noted). Cinders noted between 15 and 17 feet. MW-106 - Silt with cinder at 9-18 feet		TL-11.75-00 (13-14') Total BTEX - 290 Total PAHs - ND Fingerprint - Petrogenic NAPL with kerosene-range hydrocarbons	Distinct TarGOST responses were observed at 13 to 14 feet and at 16.2 feet. These were likely due to presence and interference of other petroleum product, as evidenced by low PAH and high BTEX concentrations. No enhanced reponses due to matrix observed in TarGOST data; dark brown peat/peaty clay absent from boring.
TL12-01.5	30.1	0-30	No	385.6	7.2	TL12-01.5	TL12-01.5	TL12-01.5 - Fill (gravelly sand, crushed concrete, coal, brick, cinders, crushed rock to 12 feet. Product impacted from 8 to 10 feet. Fill underlain by silty clay from 12 to 20 feet (bottom of boring); from 12 to 15 feet some product was observed coating silt; obvious odor noted.		TL12-1.5 (7.1-10') Total BTEX - 0.2 Total PAHs - 5.8 Fingerprint - Possible Fuel Oil #6	Several distinct TarGost reponses noted between 7 and 10 feet likely due to presence and interference of other petroleum product, as evidenced by low PAH and low BTEX concentrations but visual confirmation of staining in the 8 to 10 foot interval. No enhanced reponses due to matrix observed in TarGOST data; dark brown peat/peaty clay absent from boring.
TL12-00.5	30.1	0-16.5	No	777.0	5.4	TL12-00.5, MW-106, MW-120B	TL12-00.5, MW-106, MW-120B, MW-106A, TL11.75-00	See above for TL11.75-00 lithology. TL12-00.5 - Fill (concrete, gravel, sand, coal, and wood) to 16.5 feet. Wood present near 7 feet. Between approximately 7 and 10 feet gravel and coal present, with possible trace residual product staining, and slightly obvious odor. Fill underlain by silt, with some wood. Obvious odor and possible product staining noted between 18.25 and 20 feet. Residual, shiny product with obvious odor observed at 20-25 feet.	Shiny product	TL12-00.5 (17.5-19.5') Total BTEX - 66.1 Total PAHs - 1381	Elevated response in surface layer was likely due to presence and interference of other petroleum product, as evidenced by subsequent fingerprinting analysis that indicated presence of kerosene range hydrocarbons.
		16.5-25	Yes	37.1	20.9			The maximum TarGOST response in the middle segment of this boring occurs within in the interval where residual product was noted. The instrument response was elevated with respect to the surrounding material between 20.5 and 22 feet.			
		25-30.1	No	11.6	25.5						
TL12.5-00	23.0	0-21.7	No	52.6	7.5	TL12.5-00, GZA-45, MW-120B, MW-120A	TL12.5-00, GZA-45, MW-120B, MW-120A, TL12-00.5	See above for 12.5-00.5 lithology. TL12-5-00 - Fill (sand, gravel, schist, crushed brick and rock) to bottom of boring (22 feet). Some cinder at noted between six and nine feet; bpttom of boring described as slough.		GZA-45 (5.5-6') Total BTEX - 12.8 Total PAHs -683	Some elevated TarGOST signals observed between 7.5 and 9 feet, as well as near the bottom of the boring; possibly due to interference of other petroleum product as evidenced by chemistry data (GZA-45 sample). Additionally, possible trace residual product was also noted in from 7 to 10 feet in nearby boring TL12-00.5.
		21.7-22.3	Yes	146.8	22.1			Cinder, ash, and slag noted in nearby borings between 5 and 10 feet: GZA-45 - Silt with cinders/ash at 5-10 feet			NAPL zone at 21.7-22.3 feet as indicated by TarGOST response.
		22.3-23	No	7.8	22.8			MW-120B - Silt, some cinders/slag at 6.25-7.7 feet			
TL12.5-10.5	30.1	0-13.1	No	39.4	13.0	TL12.5-10.5	TL12.5-10.5	TL12.5-10.5 - Fill (silt, sand, gravel, trace bring and asphalt) to 15 feet. Incandescent sheen at 8 feet with barely obvious product odor; black incandescent sheen observed at 14.5-15 feet. Fill is underlain by very dark brown peat/peaty clay to 30 feet (bottom of boring).	Black incandescent sheen		Distinct TarGOST response observed between 13 and 16 feet; NAPL zone visually confirmed from 14.5 to 15 feet in co-located boring.
		13.1-15	Yes	66.0	13.1						Some enhancement of response it observed in lower segment of boring due to soil matrix (peat).
		15-30.1	No	47.0	15.4						
TL13.5-10.5	35.0	0-6.1	No	68.6	4.7	TL13.5-10.5	TL13.5-10.5, SB-22, MW-136	TL13.5-10.5 - Fill (gravel, sand, crushed brick and concrete) to 10 feet. Product and obvious odor noted between 6 and 10 feet. No recovery from 10 to 25 feet; from 25 to 35 was clayey peat, brown in color from 25 to 30 feet and dark grey from 30 to 35 feet.	Black liquid product with odor.	TL-13.5-10.5 (7.5-9.5') Total BTEX - 261 Total PAHs - 10022	No product observed visually
		6.1-10	Yes	101.3	9.2						NAPL confirmed visually and with analytical data.
		10-12.1	No	10.1	41.9			SB-22 - Cinder and slag at 15-20 feet. Clayey peat at 20-25 feet (bottom of boring). MW-136 - Peaty clay at 15-25 feet.			NAPL zone at 12.1-12.5 feet as determined by distinct TarGOST response.
		12.1-12.5	Yes	88.7	12.4						Enhanced response observed between 15 and 30 feet likely due to soil matrix (peat).
		12.5-30.1	No	66.8	27.4						

TABLE 2-2
Correlation of TarGOST® Results with Conventional Data
Quanta Resources Superfund site, OUI
Edgewater, New Jersey

TarGOST® Location	Total TarGOST® Boring Depth	Interval		Max. Signal (%RE)	Depth of Max Signal (ft bgs)	Adjacent and/or Collocated Borings			Description of Tar/ Product Observed	Associated Analytical Soil Results for Select Compounds (mg/kg) ⁵	Comments/Conclusions
		Depth Range	NAPL			NAPL Boring ID ¹	Lithology Boring ID ²	Visual Description(s) ³			
TL13.5-12.75	30.0	0-30	No	14.0	7.5	TL13.5-12.75	TL13.5-12.75	TL13.5-12.75 - Fill (crushed rock, concrete, sand, and gravel) to 7.5 feet. Odor noted near 5 feet. Organic clay from 7.5 to 12 feet; lean silt from 12 to 17 feet; stiff, fat clay from 17 to 20 feet.		TL-13.5-12.75 (8-9') Total BTEX - ND Total PAHs - 2.8	No enhanced reponses due to matrix observed in TarGOST data; dark brown peat/peaty clay absent from boring.
TL14-12.25	30.1	0-30	No	78.3	14.5		SB-26, SB-30, TL14.5-11.25	TL14.5-11.25 - Fill (silty gravel, sand) to approximately 5.5 to 6 feet. Clayey peat at 7-10 feet; black brittle product observed, odor noted. Clayey peat underlain by interlayered clayey sand and sandy clay layers. Sand was noted to contain some organic matter. SB-26 - Very dark brown clayey peat/peat from 12.5 to 20.5 feet. SB-30 - Clayey peat at 15-20 feet (bottom of boring).			Enhanced response observed between 10 and 15 feet likely due to soil matrix (peat). The very dark brown peat/clayey peat resulting in enhanced TarGOST response throughout the site was present from 12.5 to 20.5 feet in nearby boring SB-26.
TL14-13.25	30.1	0-30.1	No	91.6	10.5	TL14-13.25	TL14-13.25, SB-26, SB-30	TL14-13.25 - Fill (silt, sand, gravel) to 10 feet. Small amount of black, vitreous,tar-like, viscous product coating gravel at 2.5 feet, 0.5 foot thickness or less, odor present. Similar material observed at 3 feet, but more solid vesicular compacted material Very dark brown peat/peaty clay present from 10 to 15 feet; underlain by stiff clay from 15 to 20 feet.			Enhanced response observed between 10 and 15 feet due to soil matrix (peat).
TL14.5-11.75	28.4	0-28.4	No	55.6	0.5		TL14.5-11.25, SB-13	See above for lithology at TL14.5-11.25			Response potentially due to vegetation or asphalt debris near surface or probe window not having fully penetrated ground surface. Response occurs over an extremely narrow range (0.05 foot). General response for the top 1 foot is less than 20%. Enhanced response observed from 10 to 22 feet likley due to soil matrix (peat, inferred).

Notes:

*Analytical data included only if major constituents exceed 2004 proposed NJ DEP Soil Cleanup Criteria.
%RE - TarGOST® response measured as percent of a reference emitter
DNAPL - Dense Non-Aqueous Phase Liquid
ft bgs - feet below ground surface
HPT - Hard Pitch Tar
ICS - Incandescent Sheen
mg/kg - milligrams per kilogram
SCF - Slag, Cinder, Fill
¹ - NAPL Boring ID's were determined by using any soil boring within 15 feet of original TarGost ® Boring.
² - Lithology Boring ID's were determined by using any boring within 40 feet of original TarGost ® Boring.
³ - Visual observations pertaining to NAPL were only taken from NAPL borings. If there were no boring logs, observation is left blank
⁴ - The original TarGOST ® boring locations depth was used
⁵ - Analytical Results were taken only from NAPL Boring's and within 1 vertical foot of Max Signal

TABLE 2-3
Soil Sample Analytical Summary
Quanta Resources Superfund Site, OU1
Edgewater, New Jersey

Property	Location	Sample ID	Start Depth (ft bgs)	End Depth (ft bgs)	Sample Date	Parameter							
						Arsenic	Arsenic SEP*	TAL Metals	VOCs	SVOCs	PCBs	TPH Fingerprinting (DRO/GRO)	Total Organic Carbon
Block 93 South	MW-123	SB-123-0.75	0.5	1	9/11/08			X	X	X	X		
Block 93 South	MW-123	SB-123-4.25	4	4.5	9/11/08			X	X	X	X		
Block 93 South	MW-124	SB-124-1.5 DUP-091208	1	2	9/12/08			X	X	X	X		
Block 93 South	MW-124	SB-124-9.0	8	10	9/12/08			X	X	X	X		
Gorge/Old River Rd	MW-125	SB-125-4.75	4.5	5	9/15/08			X	X	X	X		
Gorge/Old River Rd	MW-125	SB-125-9.75	9.5	10	9/15/08			X	X	X	X		
Gorge Rd	MW-126	SB-126-11.25	11	11.5	10/14/08			X	X	X	X		X
Gorge Rd	MW-126	SB-126-15.5	15.25	15.75	10/14/08		X						
Gorge Rd	MW-126	SB-126-22.5	22	23	10/14/08	X							X
	MW-126	SB-126-22.6	22	23	10/14/08		X						
Gorge Rd	MW-126	SB-126-4.5	4.3	4.8	10/14/08			X	X	X	X		X
Block 93 Central	MW-127	SB-127-1.75	1.5	2	9/11/08			X	X	X	X		
Block 93 Central	MW-127	SB-127-8.25	8	8.5	9/11/08			X	X	X	X		
Block 93 Central	MW-127	SB-127-9.5	9	10	9/11/08			X	X	X	X		
Block 94	MW-128	SB-128-1.8-022409	1.5	2	2/24/09			X	X	X	X		
Block 94	MW-128	SB-128-3.8-022409	3.6	4	2/24/09			X	X	X	X		
Block 94	MW-128	SB-128-8.5	8	9	2/25/09		X						
	MW-128	SB-128-8.5-022509	8	9	2/25/09	X							X
Block 94	MW-128	SB-128-13.5	13	14	2/25/09		X						
	MW-128	SB-128-13.5-022509	13	14	2/25/09	X							X
Block 94	MW-129	SB-129-1.8-022409	1.6	2	2/24/09			X	X	X	X		
Block 94	MW-129	SB-129-7.5-022409 DUP-022409	7	8	2/24/09			X	X	X	X		
	MW-130B	SB-130-15.5	15.3	15.8	10/9/08		X						
Former Lever Brothers	MW-130B	SB-130-16.5	16	17	10/9/08	X							X
Former Lever Brothers	MW-130B	SB-130-20.5	20	21	10/9/08	X							X
	MW-130B	SB-130-20.6	20	21	10/9/08		X						
	MW-131	SB-131-6.0	5.75	6.25	10/6/08		X						
Former Lever Brothers	MW-131	SB-131-7.5	7	8	10/6/08	X							X
Former Lever Brothers	MW-131	SB-131-19.5	19.25	19.75	10/6/08	X	X						X
Former Lever Brothers	MW-132	SB-132-8.5 DUP-100708	8	9	10/7/08	X							X
	MW-132	SB-132-10.75	10.5	11	10/7/08		X						
Former Lever Brothers	MW-132	SB-132-19.5	19	20	10/7/08	X							X
Former Celotex	MW-133	SB-133-13.25	13	13.5	10/2/08	X	X						X
Former Celotex	MW-134	SB-134-14.75	14.5	15	10/1/08	X	X						X
Former Celotex	MW-134	SB-134-17.5	17	18	10/1/08	X	X						X
Block 93 Central	MW-136	SB-136-1.0	0.5	1	9/10/08			X	X	X	X		
Block 93 Central	MW-136	SB-136-8.5	8.5	9.5	9/10/08			X	X	X	X		
Block 93 Central	MW-136	SB-136-21.5	21	22	9/10/08			X	X	X	X		
Quanta	PZ-7	SB-PZ7-16.25	16	16.5	9/19/08				X	X			
Block 94	SB-39	SB-39-1.0-022409	0.8	1.2	2/24/09			X	X	X	X		
Block 94	SB-39	SB-39-5.3-022409	5	5.5	2/24/09			X	X	X	X		
Block 93 Central	SB-40	SB-40-1.0	0	1.5	8/26/08			X	X	X	X		
Block 93 Central	SB-40	SB-40-4.0	3.8	5	8/26/08			X	X	X	X		
Block 93 Central	SB-42	SB-42-1.0	0	1.5	8/26/08			X	X	X	X		
Block 93 Central	SB-42	SB-42-9.0	8.5	10	8/26/08			X	X	X	X		
Block 93 Central	SB-43	SB-43-0.5	0	1	8/26/08			X	X	X	X		
Block 93 Central	SB-43	SB-43-3.5	3	4	8/26/08			X	X	X	X		
Block 93 Central	SB-44	SB-44-1.0	0.5	1.5	9/4/08			X	X	X	X		
Block 93 Central	SB-44	SB-44-8.0	7	9	9/4/08			X	X	X	X		
Block 93 South	SB-47	SB-47-3.2	2.7	3.7	8/27/08			X	X	X	X		
Block 93 South	SB-47	SB-47-1.5	1	2	8/27/08			X	X	X	X		
Block 93 South	SB-48	SB-48-6.0	5	7	8/27/08			X	X	X	X		
Gorge/River Rd	SB-49	SB-49-4.5	4	5	9/2/08			X	X	X	X		
Gorge/River Rd	SB-49	SB-49-9.5	9	10	9/2/08			X	X	X	X		
Gorge/River Rd	SB-50	SB-50-3.0	2.5	3.5	9/2/08			X	X	X	X		
Gorge/River Rd	SB-50	SB-50-11.25	11	11.5	10/16/08			X	X	X	X		
Gorge/River Rd	SB-51	SB-51-3.5	3	4	9/2/08			X	X	X	X		
Gorge/River Rd	SB-51	SB-51-18	17.5	18.5	9/2/08			X	X	X	X		
Block 92.01	SB-52	SB-52-3.0-022409	2	4	2/24/09			X	X	X	X		
Block 92.01	SB-52	SB-52-6.0-022409	5.7	6.3	2/24/09			X	X	X	X		
Quanta	SB-53	SB-53-3.0	2.5	3.5	9/5/08	X							X
	SB-53	SB-53-SZone	2.5	3.5	9/5/08		X						
Quanta	SB-53	SB-53-16.5	16	17	9/5/08	X							X
	SB-53	SB-53-16.6	16	17	9/5/08		X						
Former Celotex	SB-54	SB-54-10.5	10.25	10.75	10/3/08	X	X						X
Former Celotex	SB-54	SB-54-22.75	22.5	23	10/3/08	X	X						X
	SB-55	SB-55-13.75	13.5	14	10/8/08		X						
Former Lever Brothers	SB-55	SB-55-19.5	19	20	10/7/08	X	X						X
Former Lever Brothers	SB-55	SB-55-5.25	5	5.5	10/8/08	X							X
Block 92.01	SB-58	SB-58-3.7-022509	3.5	4	2/25/09			X	X	X	X		
Block 92.01	SB-58	SB-58-9.5-022509	9.3	9.7	2/25/09			X	X	X	X		

TABLE 2-3
Soil Sample Analytical Summary
Quanta Resources Superfund Site, OU1
Edgewater, New Jersey

Property	Location	Sample ID	Start Depth (ft bgs)	End Depth (ft bgs)	Sample Date	Parameter							
						Arsenic	Arsenic SEP*	TAL Metals	VOCs	SVOCs	PCBs	TPH Fingerprinting (DRO/GRO)	Total Organic Carbon
Block 92.01	SB-58	SB-58-11.7-022509	11.3	12	2/25/09			X	X	X	X		
Block 93 Central	SS-58	SS-58-0.1	0.1	0.2	10/15/08			X	X	X	X		
Block 93 South	TL08.5-10.5	TL 8.5-10.5-0.5	0	1	8/28/08			X	X	X	X		
Block 93 South	TL08.5-10.5	TL 8.5-10.5-13*	12	14	8/28/08			X	X	X	X		
Block 93 South	TL09.5-10.5	TL 9.5-10.5-1.5	1	2	8/28/08			X	X	X	X		
Block 93 South	TL09.5-10.5	TL 9.5-10.5-3.5	3	4	8/28/08			X	X	X	X		
Block 93 South	TL09.5-10.5	TL 9.5-10.5-16.5	16	17	8/28/08			X	X	X	X		
Block 93 South	TL09.5-11.25	TL 9.5-11.25-0.5	0	1	8/28/08			X	X	X	X		
Block 93 South	TL09.5-11.25	TL 9.5-11.25-7.5	5	10	8/28/08			X	X	X	X		
Former Lever Brothers	TL09-09	TL09-09-1.0	0.5	1.5	8/29/08			X	X	X	X		
Former Lever Brothers	TL09-09	TL09-09-4.5	4	5	8/29/08			X	X	X	X		
Former Lever Brothers	TL09-09	TL09-09-19.5	19.3	20	8/29/08			X	X	X	X		
Former Lever Brothers	TL10.5-09.5	TL10.5-9.5-1.0 DUP-082908	0	1.5	8/29/08			X	X	X	X		
Former Lever Brothers	TL10.5-09.5	TL10.5-9.5-9.5	9	10	8/29/08			X	X	X	X		
Former Lever Brothers	TL10.5-09.5	TL10.5-9.5-23.5	23	24	8/29/08			X	X	X	X		
Block 93 South	TL10.5-10.5	TL 10.5-10.5-0.5	0	1	8/27/08			X	X	X	X		
Block 93 South	TL10.5-10.5	TL 10.5-10.5-4.0	3.5	4.5	8/27/08			X	X	X	X		
Block 93 South	TL10.5-10.5	TL 10.5-10.5-14.5 DUP-082708	14	15	8/27/08			X	X	X	X		
Block 93 South	TL10.5-11.25	TL 10.5-11.25-0.5	0	1	8/28/08			X	X	X	X		
Block 93 South	TL10.5-11.25	TL 10.5-11.25-8.5	8	9	8/28/08			X	X	X	X		
Block 93 South	TL10.5-11.25	TL 10.5-11.25-12	11	12	8/28/08			X	X	X	X		
Former Lever Brothers	TL10-09.5	TL 10-9.5-7.5 DUP-090408	6.5	8.5	9/4/08			X	X	X	X		
Former Lever Brothers	TL11.25-00	TL 11.25-00-17.5	16.5	18.5	9/4/08			X	X	X	X	X	
Former Lever Brothers	TL11.75-00	TL 11.75-00-13.5	13	14	9/3/08			X	X	X	X	X	
Block 93 South	TL11-11.75	TL 11-11.75-11	10	12	8/27/08			X	X	X	X		
Former Lever Brothers	TL12.5-00	TL 12.5-00-17.5	17	18	9/3/08			X	X	X	X	X	
Block 93 Central	TL12.5-10.5	TL 12.5-10.5-1.5	0.25	2.5	8/25/08			X	X	X	X		
Block 93 Central	TL12.5-10.5	TL 12.5-10.5-8.5	7.5	9.5	8/25/08			X	X	X	X		
Former Lever Brothers	TL12-00.5	TL 12-0.5-7.5	7	8	9/3/08			X	X	X	X	X	
Former Lever Brothers	TL12-00.5	TL 12-0.5-18.5	17.5	19.5	9/3/08			X	X	X	X	X	
Former Lever Brothers	TL12-01.5	TL12-1.5-8.5	7.1	10	8/29/08			X	X	X	X	X	
Block 93 Central	TL13.5-10.5	TL 13.5-10.5-1.5	0.5	2.5	8/25/08			X	X	X	X		
Block 93 Central	TL13.5-10.5	TL 13.5-10.5-8.5	7.5	9.5	8/25/08			X	X	X	X		
Block 93 Central	TL13.5-12.75	TL 13.5-12.75-0.5	0	1	8/26/08			X	X	X	X		
Block 93 Central	TL13.5-12.75	TL 13.5-12.75-8.5	8	9	8/26/08			X	X	X	X		
Block 93 North	TL14-13.25	TL 14-13.25-8.5	7.5	9.5	8/25/08			X	X	X	X		
Block 93 North	TL14-13.25	TL 14-13.25-1.0	0.4	1.5	8/25/08			X	X	X	X		

Notes:

*Arsenic SEP samples were collected from a separate collocated boring at depths comparable to those of the sample listed.

ft bgs - feet below ground surface

DRO - diesel-range organics

GRO - gasoline-range organics

PCB - polychlorinated biphenyl

SVOC - semi-volatile organic compound

TPH - total petroleum hydrocarbons

VOC - volatile organic compound

SEP - Sequential Extraction Procedure

Analytical methods utilized are as follows:

Arsenic: Method 6010

Arsenic SEP: Sequential Extraction Procedure (SEP)

Diesel Range Organics: Method SW8015

Fingerprinting: Method EPA 8100M

Full Petroleum Biomarkers: Method EPA 8270M

Gasoline Range Organics: Method SW8015

Grain Size: Method ASTM D422

PAHs/Petroleum Biomarkers: EPA 8270M

PCBs: Method SW8082

SVOCs: Method SW8270

TAL Metals: Methods 6010 and SW7471

Total Organic Carbon: Method SW9060

TPH Fingerprint: Method SW8015

TPH: Method SW8015SW

VOCs: Method SW8260

TABLE 2-4

Monitoring Well Construction Summary
 Quanta Resources Superfund Site, OU1
 Edgewater, New Jersey

Well ID	Diameter/ Construction/ Slot Size	Northing	Easting	Measuring Point Elevation (TIC) (ft msl) ¹	Ground Elevation (ft msl) ²	Property	Screened Hydro- stratigraphic Unit	Top of Screen (ft bgs)	Top of Screen (ft msl)	Bottom of Screen (ft bgs)	Bottom of Screen (ft msl)	Screen Length (ft)
Groundwater Monitoring Wells												
MW-123	4" PVC/20 slot	718728.96	632591.99	5.54	6.0	Block 93 South	S	5	1.0	10	-4.0	5
MW-124	2" PVC/20 slot	718620.61	632423.84	7.48	7.7	Block 93 South	S	6	1.7	16	-8.3	10
MW-125	2" PVC/20 slot	719375.31	632626.42	11.97	12.4	Gorge/Old River Rd	S	5	7.4	15	-2.6	10
MW-126	2" PVC/20 slot	719166.66	632793.59	13.87	14.3	Gorge Rd	S	8	6.3	18	-3.7	10
MW-127	2" PVC/20 slot	718828.53	632458.81	6.35	6.8	Block 93 Central	S	6	0.8	16	-9.2	10
MW-128	2" PVC/20 slot	719191.81	632438.65	8.69	9.0	Block 94	S	5	4.0	15	-6.0	10
MW-129	2" PVC/20 slot	719073.57	632425.96	7.29	7.8	Block 94	S	5	2.8	15	-7.2	10
MW-130A	2" PVC/20 slot	718485.12	633029.60	6.34	6.7	Former Lever Brothers	S	5	1.7	15	-8.3	10
MW-130B	2" PVC/20 slot	718487.18	633030.76	6.47	6.7	Former Lever Brothers	I	15	-8.3	25	-18.3	10
MW-131	2" PVC/20 slot	718179.94	633097.72	6.88	7.2	Former Lever Brothers	S	4	3.2	14	-6.8	10
MW-132	2" PVC/20 slot	718079.22	633160.00	5.90	6.3	Former Lever Brothers	S	4	2.3	14	-7.8	10
MW-133	2" PVC/20 slot	718804.18	633478.47	15.38	15.7	Former Celotex	S	10	5.7	15	0.7	5
MW-134	2" PVC/20 slot	718686.21	633687.67	14.13	14.5	Former Celotex	S	11	3.5	21	-6.5	10
MW-135	4" PVC/20 slot	718635.16	633660.04	15.00	15.2	Former Celotex	I	20	-4.8	30	-14.8	10
MW-136	2" PVC/20 slot	718854.68	632600.74	5.02	5.3	Block 93 Central	S	5	0.3	10	-4.7	5
OU1 and OU2 Piezometers												
PZ-1D	0.25" SS/6 slot	718637.82	633749.72	4.11	-0.9	Hudson River	NA	20.3	-21.2	20.8	-21.7	0.5
PZ-1I	0.25" SS/6 slot	718640.72	633728.48	4.24	-0.8	Hudson River	NA	15.8	-16.6	16.3	-17.1	0.5
PZ-1S	0.25" SS/6 slot	718640.50	633729.55	3.71	-0.8	Hudson River	NA	4.8	-5.7	5.3	-6.2	0.5
PZ-2D	0.25" SS/6 slot	718539.91	633667.09	8.56	-1.3	Hudson River	NA	20.9	-22.2	21.4	-22.7	0.5
PZ-2I	0.25" SS/6 slot	718540.05	633666.98	8.30	-1.2	Hudson River	NA	14.8	-16.0	15.3	-16.5	0.5
PZ-2S	0.25" SS/6 slot	718539.85	633666.93	8.24	-1.2	Hudson River	NA	4.3	-5.5	4.8	-6.0	0.5
PZ-3D	1.5" SS/12 slot	718404.03	633625.91	5.54	-1.7	Hudson River	NA	23.4	-25.0	24.4	-26.0	1
PZ-3I	1.5" SS/12 slot	718404.03	633625.91	5.39	-1.7	Hudson River	NA	14.7	-16.4	15.7	-17.4	1
PZ-3S	0.25" SS/6 slot	718404.16	633624.62	5.57	-1.6	Hudson River	NA	4.4	-6.0	4.9	-6.5	0.5
PZ-4D	0.25" SS/6 slot	718184.59	633525.17	4.68	-0.6	Hudson River	NA	21.1	-21.7	21.6	-22.2	0.5
PZ-4I	0.25" SS/6 slot	718186.13	633526.67	4.39	-0.6	Hudson River	NA	14.6	-15.2	15.1	-15.7	0.5
PZ-4S	0.25" SS/6 slot	718186.14	633523.42	4.43	-0.6	Hudson River	NA	3.4	-4.0	3.9	-4.5	0.5
PZ-5D	1.5" SS/12 slot	718484.76	633748.89	3.65	-1.7	Hudson River	NA	22.4	-24.1	23.4	-25.1	1
PZ-5I	1.5" SS/12 slot	718485.03	633749.10	3.62	-1.7	Hudson River	NA	13.7	-15.5	14.7	-16.5	1
PZ-5S	1.5" SS/12 slot	718485.21	633749.12	3.58	-1.7	Hudson River	NA	1.6	-3.4	2.6	-4.4	1
PZ-6D	2" PVC/20 slot	718579.95	633648.02	5.79	6.0	Quanta	BR	28	-22.0	30	-24.0	2
PZ-6I	1" PVC/20 slot	718579.95	633648.02	5.74	6.0	Quanta	I	16	-10.0	18	-12.0	2
PZ-6S	1" PVC/20 slot	718579.95	633648.02	5.72	6.0	Quanta	S	6	0.0	8	-2.0	2
PZ-7D	2" PVC/20 slot	718511.80	633625.02	5.69	6.0	Quanta	I	33	-27.0	35	-29.0	2
PZ-7I	1" PVC/20 slot	718511.80	633625.02	5.66	6.0	Quanta	I	21	-15.0	23	-17.0	2
PZ-7S	2" PVC/20 slot	718511.80	633625.02	5.71	6.0	Quanta	S	8	-2.0	10	-4.0	2
PZ-8D	2" PVC/20 slot	718374.96	633554.42	4.53	4.8	Quanta	D	54	-49.2	56	-51.2	2
PZ-8I	1" PVC/20 slot	718374.96	633554.42	4.39	4.8	Quanta	I	38	-33.2	40	-35.2	2
PZ-8S	2" PVC/20 slot	718374.96	633554.42	4.46	4.8	Quanta	S	6	-1.2	8	-3.2	2

Notes:

ft - feet

ft msl - feet above mean sea level, NAVD 88

ft bgs - feet below ground surface

PVC - polyvinyl chloride

SS - stainless steel

TIC - top of monitoring well inner casing

S = Shallow unconfined groundwater - Well screen set at or near the water table

I = Deeper unconfined groundwater - Well screen set at or immediately above silty-clay aquitard

D = Deep sand - Well screen set below silty-clay aquitard

BR = Bedrock - Well screen set in bedrock

NA = Not Applicable

¹: The measuring point for PZ-1 through PZ-5 locations is the top of polyethylene tubing.²: Sediment surface elevation is recorded for PZ-1 through PZ-5 locations.

TABLE 2-5

Groundwater, Pore Water, and Surface Water Analytical Summary

Quanta Resources Superfund Site, OU1

Edgewater, New Jersey

Property	Location	Sample ID	Sample Date	Sample Start Depth (ft bgs)	Sample End Depth (ft bgs)	Sample Type	Parameter					
							TAL Metals	VOCs	SVOCs	PCBs	As Speciation	WetChem
Gorge/Old River Rd	MW-125	MW-125-122308	12/23/08	5	15	GW	X	X	X	X		X
Gorge/Old River Rd	MW-125	MW-125-010909* DUP-010909*	1/9/09	5	15	GW	X					X
Gorge/Old River Rd	MW-126	MW-126-123108	12/31/08	8	18	GW	X	X	X	X	X	X
		Dup-123108				GW	X	X	X	X		X
Quanta	MW-103A	MW-103A-120208	12/2/08	3	13	GW	X	X	X			X
Quanta	MW-105A	MW-105A-121008	12/10/08	3	13	GW	X	X	X		X	X
Quanta	MW-112A	MW-112A-121708	12/17/2008	3	10	GW	X					X
Quanta	MW-112B	MW-112B-120908	12/9/2008	2	12	GW	X				X	X
Quanta	MW-113A	MW-113A-120108	12/1/2008	3	13	GW	X					X
Quanta	MW-113B	MW-113B-120908	12/9/2008	9	19	GW	X	X	X		X	X
Quanta	MW-113C	MW-113C-120108	12/1/2008	25	30	GW	X					X
Quanta	MW-117B	MW-117B-120208 DUP-120208	12/2/2008	5	15	GW	X	X	X			X
Quanta	MW-117B	MW-117B-010809*	1/9/2009	5	15	GW	X					X
Lever Brothers	MW-106A	MW-106A-120408	12/4/2008	3	13	GW	X	X	X			X
Lever Brothers	MW-107A	MW-107A-121908	12/19/2008	3	13	GW	X	X	X		X	X
Lever Brothers	MW-109	MW-109-120408	12/4/2008	15	20	GW	X	X	X			X
Lever Brothers	MW-109	MW-109-011309*	1/13/2009	15	20	GW	X					X
Lever Brothers	MW-115A	MW-115A-121908	12/19/2008	3	13	GW	X	X	X		X	X
Lever Brothers	MW-115B	MW-115B-120808	12/8/2008	15.5	25.5	GW	X	X	X			X
Lever Brothers	MW-130A	MW-130A-121908	12/19/2008	5	15	GW	X	X	X	X	X	X
Lever Brothers	MW-130B	MW-130B-122208	12/22/2008	15	25	GW	X	X	X	X	X	X
Lever Brothers	MW-131	MW-131-120808	12/8/2008	4	14	GW	X	X	X	X	X	X
Lever Brothers	MW-132	MW-132-121808	12/18/2008	4	14	GW	X	X	X	X	X	X
Lever Brothers	MW-20	MW-20-121008	12/10/2008	7	17	GW	X	X	X		X	X
Lever Brothers	MW-30	MW-30-120408	12/4/2008	2	12	GW	X	X	X			X
Lever Brothers	MW-51A	MW-51A-123008 Dup-123008	12/30/2008	3	14	GW	X	X	X		X	X
Edgewater	ACMW-3	ACMW-3-121708	12/17/2008	3	23	GW	X					X
Edgewater	MW-133	MW-133-121008	12/10/2008	10	15	GW	X	X	X	X	X	X
Edgewater	MW-134	MW-134-121008	12/10/2008	11	21	GW	X	X	X	X	X	X
Edgewater	MW-135	MW-135-120308	12/3/2008	20	30	GW	X	X	X	X		X
Edgewater	MW-A-1	MW-A-1-120308	12/3/2008	24	28	GW	X				X	X
Edgewater	MW-A-2	MW-A-2-123008	12/30/2008	6	16	GW	X	X	X		X	X
Edgewater	MW-B	MW-B-120308	12/3/2008	9	19	GW	X	X	X			X
Edgewater	MW-C	MW-C-121708	12/17/2008	10	20	GW	X	X	X			X
Edgewater	MW-F	MW-F-121808	12/18/2008	7	17	GW	X	X	X		X	X
Edgewater	MW-J	MW-J-011309*	1/13/2009	8	18	GW	X					X
Edgewater	MW-M	MW-M-011309*	1/13/2009	18	23	GW	X					X
Edgewater	MW-N-1	MW-N-1-122908	12/29/2008	18.5	23.5	GW	X					X
Edgewater	MW-N-2	MW-N-2-123008	12/30/2008	5	10	GW	X	X	X		X	X
Edgewater	MW-O	MW-O-121808	12/18/2008	9.5	19.5	GW	X	X	X		X	X
Block 93 South	MW-123	MW-123-122908	12/29/2008	5	10	GW	X	X	X	X		X
Block 93 South	MW-124	MW-124-122408	12/24/2008	6	16	GW	X	X	X	X		X
		MW-124-010909*	1/9/2009			GW	X					X
Block 93 North	3Y-MW2	3Y-MW-2-122908	12/29/2008	3	20	GW	X	X	X			X
Block 93 North	MW-101A	MW-101A-121808	12/18/2008	4	19	GW	X					X
Block 93 North	MW-111B	MW-111B-122308	12/23/2008	3	13	GW	X	X	X		X	X
Block 93 Central	MW-127	MW-127-122408	12/24/2008	6	16	GW	X	X	X	X		X
Block 93 Central	MW-136	MW-136-122308	12/23/2008	5	10	GW	X	X	X	X		X
115 River Road	MW-114A	MW-114A-010409	1/4/2009	3	13	GW	X	X	X		X	X
115 River Road	MW-114B	MW-114B-010409	1/4/2009	15	25	GW	X	X	X		X	X
115 River Road	MW-121A	MW-121A-010409	1/4/2009	3	13	GW	X	X	X			X
115 River Road	MW-121B	MW-121B-010409	1/4/2009	12	22	GW	X	X	X			X
Block 94	MW-128	MW-128-031809	3/18/2009	5	15	GW	X	X	X	X	X	X

TABLE 2-5

Groundwater, Pore Water, and Surface Water Analytical Summary

Quanta Resources Superfund Site, OU1

Edgewater, New Jersey

Property	Location	Sample ID	Sample Date	Sample Start Depth (ft bgs)	Sample End Depth (ft bgs)	Sample Type	Parameter					
							TAL Metals	VOCs	SVOCs	PCBs	As Speciation	WetChem
Block 94	MW-129	MW-129-031809	3/18/2009	5	15	GW	X	X	X	X		X
Block 92.01	MW-L	MW-L-122908	12/29/2008	17	27	GW	X	X	X			X
OU2	GWZ-1	GWZ-1-PW-071808	7/18/2008	1	2	PW	X	X	X		X	
	GWZ-1	GWZ-1-SW-071808	7/18/2008	**	**	SW	X	X	X			
OU2	GWZ-2	GWZ-2-PW-072108	7/21/2008	1	2	PW	X	X			X	
	GWZ-2	GWZ-2-SW-072108	7/21/2008	**	**	SW	X	X	X			
OU2	GWZ-3	GWZ-3-PW-072209	7/22/2008	1	2	PW	X	X	X		X	
	GWZ-3	GWZ-3-SW-072208	7/22/08	**	**	SW	X	X	X			
OU2	GWZ-4	GWZ-4-PW-072408	7/24/08	1	2	PW	X	X	X		X	
	GWZ-4	GWZ-4-SW-072408	7/24/08	**	**	SW	X	X	X			
OU2	GWZ-5	GWZ-5-PW-072508 DUP-072508	7/25/08	1	2	PW	X	X	X		X	
	GWZ-5	GWZ-5-SW-072508	7/25/08	**	**	SW	X	X				
OU2	PZ-1D	PZ1D-010809	1/8/2009	20.3	20.8	PW		X	X			
		PZ1D-022509	2/25/2009			PW			X			
OU2	PZ-1I	PZ1I-010909	1/9/2009	15.8	16.3	PW		X	X			
		PZ1I-022509	2/25/2009			PW			X			
OU2	PZ-2D	PZ2D-010609	1/6/2009	20.9	21.4	PW	X	X	X			
OU2	PZ-2I	PZ2I-010709	1/7/2009	14.8	15.3	PW		X	X			
		PZ2I-022709	2/27/2009			PW			X			
OU2	PZ-2S	PZ2S-010809	1/8/2009	4.28	4.78	PW		X	X			
		PZ2S-022709	2/27/2009			PW			X			
OU2	PZ-3D	PZ3D-010709	1/7/2009	23.4	24.4	PW		X	X			
		PZ3D-011309	1/13/2009			PW	X		X			
		PZ3D-022509	2/25/2009			PW	X					
OU2	PZ-3I	PZ3I-010709	1/7/2009	14.7	15.7	PW		X	X			
		PZ3I-011109	1/8/2009			PW	X					
		PZ3I-011309	1/13/2009			PW	X					
OU2	PZ-3S	PZ3S-010709	1/7/2009	4.4	4.9	PW		X	X			
		PZ3S-011309	1/13/2009			PW	X					
		PZ3S-022509	2/25/2009			PW	X					
OU2	PZ-4I	PZ4I-010709	1/7/2009	14.6	15.1	PW	X	X	X			
OU2	PZ-4S	PZ4S-010709	1/7/2009	3.4	3.9	PW	X	X	X			
OU2	PZ-5D	PZ5D-010809	1/8/2009	22.4	23.4	PW		X	X			
		PZ5D-022509	2/25/2009			PW			X			
OU2	PZ-5I	PZ5I-010809	1/8/2009	13.7	13.7	PW		X	X			
		PZ5I-022509	2/25/2009			PW			X			
OU2	PZ-5S	PZ5S-010809	1/8/2009	1.6	2.6	PW		X	X			
		PZ5S-022709	2/27/2009			PW			X			

Notes:

*Samples were also analyzed for total suspended solids (TSS, Method SM2540D); total dissolved solids (TDS, Methods SM2540C); and surfactants (methylene blue activated substances and linear alkylbenzene sulfonate; Method SM5540C)

**Surface water samples were collected less than 1 foot above the sediment surface

ft bgs - feet below ground surface

PCB - polychlorinated biphenyl

SVOC - semi-volatile organic compound

VOC - volatile organic compound

As - Arsenic

GW - Groundwater Sample

PW - Pore Water Sample

SW - Surface Water Sample

Analytical methods utilized are as follows:

PCBs: Method SW8082

SVOCs: Method SW8270

TAL Metals: Methods 6010 and SW7471

VOCs: Method SW8260

As Speciation: Method SW6800

WetChem:

Alkalinity - E310.1

Chloride, Fluoride, Sulfate - E300.0

TOC - SW9060

Nitrate - E353.2

Nitrite - SM4500-NO2B

Orthophosphate - E365.3

Sulfide - SM4500-SD

TABLE 2-6
Summary of Groundwater Water Quality Parameters
Quanta Resources Superfund Site, OU1
Edgewater, New Jersey

Sample Location	Property	Sampling Event	pH	Temp. (°C)	Cond. (mS/cm)	ORP (mV)	DO (mg/L)	Turbidity (NTU)	Comments
MW-108	115 River Road	Event 1	6.71	20.23	3.73	-147	0	22.1	clear, product odor
		Event 2	NS	NS	NS	NS	NS	NS	NS b/c blocked by broken excavator
		Event 3	7.03	15	4.18	-149	0.31	13	blackish grey, cloudy
		Event 4	6.24	21.62	3.13	-127.4	*	20.6	grey, no odor
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-114A	115 River Road	Event 1	NS	NS	NS	NS	NS	NS	NS b/c not yet installed
		Event 2	5.54	8.71	2.14	-109	*	8.42	brownish, product odor
		Event 3	6.94	14.94	0.909	-184	0	1.5	clear, no odor
		Event 4	6.36	23.84	1.1	-89.6	*	2.04	
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 7	7.19	9.54	0.364	-83.5	6.52	4.6	clear, no odor
		Event 1	NS	NS	NS	NS	NS	NS	NS b/c not yet installed
MW-114B	115 River Road	Event 2	6.13	13.14	4.09	-35	3.99	15.7	clear
		Event 3	6.06	14.7	3.68	-93	0.46	3.3	clear, product odor
		Event 4	6.38	16.87	1.03	-39.8	*	6.48	clear, no odor
		Event 5	7.3	15.29	55.891	-49.7	0	49.1	clear, organic odor
		Event 7	5.83	12.89	3.001	-34	2.21	6.6	clear
		Event 1	6.47	17.8	4.06	-139	0	-2.01	clear
		Event 2	5.65	10.67	5.42	-88	*	10.9	clear
MW-119A	115 River Road	Event 3	6.57	15.6	6.87	-103	0.02	15	clear, no odor
		Event 4	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 1	6.95	18.75	5.5	-277	0	2.98	clear, no odor
		Event 2	7.18	12	6.42	-240	1.01	11.9	clear
MW-119B	115 River Road	Event 3	7.12	15.2	11.7	-146	2.48	13	clear, no odor
		Event 4	6.68	21.26	8	-163.4	*	4.25	clear
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 1	NS	NS	NS	NS	NS	NS	NS b/c not yet installed
		Event 2	5.91	10.8	1.08	-101	*	9.29	clear
MW-121A	115 River Road	Event 3	7.74	14	0.286	-40	0.98	19	clear, no odor
		Event 4	6.66	19.47	0.202	-16	0.35	5.5	clear, no odor
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 7	7.01	13.74	0.765	-62.6	0.85	7.7	clear
		Event 1	NS	NS	NS	NS	NS	NS	NS b/c not yet installed
		Event 2	7.49	11.96	1.85	-152	1.2	26.7	clear
		Event 3	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL
MW-121B	115 River Road	Event 4	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 7	7.51	11.82	1.45	-72.8	10.08	35.3	clear with blackish tint, slight odor present
		Event 1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 2	7.09	14.5	2.81	-301	0	6.6	clear, strong product odor
MW-L	Block 92.01	Event 3	7.47	15.5	3.25	-273	3.21	11	yellow, sulfur odor
		Event 4	6.41	19.37	2.41	-285	*	0	black, product and sulfur odor
		Event 5	6.93	19.3	3.397	-318.9	4.81	1.07	clear, product odor
		Event 7	6.24	14.61	1.21	83.3	2.1	1.1	clear, no odor
MW-127	Block 93 Central	Event 7	6.72	13.57	1.42	-268	0.55	10.99	blackish in color with odor of rotten eggs
MW-136	Block 93 Central	Event 7	6.67	10	0.964	-101	2.43	4.11	clear
3Y-MW2	Block 93 North	Event 7	7.06	11.65	1.43	-145	3.94	8.27	no odor
MW-101	Block 93 North	Event 1	6.89	16	2.03	-140	0	17	reddish brown
		Event 2	7.08	12.2	1.66	-128	1.83	41	clear, no odor
		Event 3	6.97	14.4	1.36	-142	0	5.9	clear, musty odor
		Event 4	8.22	16.26	1.84	-130	*	16.1	clear, no odor
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 7	6.74	13.75	1.806	-84.7	8.26	83.9	cloudy, brown
		Event 1	7.08	15.36	1.26	38	1.63	1.91	clear, no odor
MW-101DS	Block 93 North	Event 2	7.34	12.94	1.16	57	3.92	3.4	clear, no odor
		Event 3	7.31	14.3	1.28	6	3.11	14	clear, no odor
		Event 4	4.62	16.37	15.4	*	0.86	5.61	clear, no odor
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 1	6.68	19.51	3.67	-195	0.73	0.8	light yellow, product odor
MW-111A	Block 93 North	Event 2	6.72	8.4	2.42	-147	1.48	9.2	
		Event 3	6.72	18.4	2.58	-127	*	1.6	clear, no odor
		Event 4	6.4	28.2	2.64	-139	0.52	1	slight orange froth, slight product odor
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 1	6.4	21.1	3.31	-155	0	1.59	light yellow, product odor
MW-111B	Block 93 North	Event 2	6.61	10.15	2.71	-119	1.17	13	
		Event 3	6.69	18	2.71	-179	0	6.4	brownish color
		Event 4	6.82	27.67	3.21	-131.2	*	6.54	clear, slight sheen
		Event 5	6.67	20.17	3.454	-184.8	3.31	3.49	clear, no odor
		Event 7	6.77	11.69	2.262	-96.6	4.26	7.94	clear

TABLE 2-6
Summary of Groundwater Water Quality Parameters
Quanta Resources Superfund Site, OU1
Edgewater, New Jersey

Sample Location	Property	Sampling Event	pH	Temp. (°C)	Cond. (mS/cm)	ORP (mV)	DO (mg/L)	Turbidity (NTU)	Comments
TWP-SB28	Block 93 North	Event 6	6.69	21.67	0.033	-150.1	0.99	38.7	Clear/None
TWP-SB29	Block 93 North	Event 6	6.67	18.31	6.819	-171.9	1.07	13	Clear/None
TWP-SB30	Block 93 North	Event 6	6.83	17.89	0.018	-180.8	0.17	116	Clear/None
TWP-SB31	Block 93 North	Event 6	7.25	15.09	0.43	-182	4.02	19	Clear/None
TWP-SB32	Block 93 North	Event 6	7.13	15.81	1.604	-180.8	2	17.3	Clear/None
TWP-SB33	Block 93 North	Event 6	8.02	18.96	1.212	120.7	1.95	12	Clear/None
MW-123	Block 93 South	Event 7	NS	NS	NS	NS	NS	NS	blackish tint and oily sheen on surface, odor present, DNAPL and LNAPL present
MW-124	Block 93 South	Event 7	6.54	14.16	1.251	119	6.54	0	clear
		Tech Imp. Study	6.55	15.18	1.259	79.7	0.21	4.46	clear, no odor
MW-128	Block 94	Event 7	6.18	10.76	1.15	192	3.09	4.3	clear, no odor
MW-129	Block 94	Event 7	6.62	11.15	0.862	161.9	2.6	5.5	clear, no odor
ACMW-1	Edgewater	Event 1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 5	3.93	15.52	3.062	224.1	4.66	17.2	cloudy white, no odor
ACMW-3	Edgewater	Event 1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 5	6.72	16.22	1.645	98.7	1.21	0	clear, no odor
		Event 7	6.67	13.87	0.646	89.5	9.18	26.9	Slightly cloudy with brownish tint
DMW-2	Edgewater	Event 1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 5	7.78	15.75	2.763	-255	*	130	clear, no odor
MW-36(E)	Edgewater	Event 1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 5	6.75	16.91	17.48	-131	1.63	23.1	clear, no odor
MW-133	Edgewater	Event 7	6.01	18.06	3.18	-9.4	2.59	8.1	
MW-134	Edgewater	Event 7	6.78	17.68	6.645	-305.7	0.83	69.1	Slightly cloudy
MW-135	Edgewater	Event 7	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL
MW-A-1	Edgewater	Event 1	NS	NS	NS	NS	NS	NS	NS b/c unable to gain access to EE wells
		Event 2	5.41	15.21	2.97	-42	0.84	8.7	clear, no odor
		Event 3	5.04	15	3.32	100	0.41	8.8	clear, no odor
		Event 4	2	17.71	1.749	*	1.13	10.16	tan, slight product odor
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 7	4.16	16	4.462	33.5	0.74	17.6	Brownish
MW-A-2	Edgewater	Event 1	NS	NS	NS	NS	NS	NS	NS b/c unable to gain access to EE wells
		Event 2	5.72	14	4.01	26	0	14	clear, no odor
		Event 3	5.73	14.6	4.11	-43	0	4.57	clear, no odor
		Event 4	4.6	19.08	2.87	*	0.9	16.8	clear, no odor
		Event 5	5.92	19.09	NS	-60	0	114	clear, product odor
		Event 7	5.38	17.23	4.071	18.4	0.61	9.3	clear, no odor
MW-B	Edgewater	Event 1	NS	NS	NS	NS	NS	NS	NS b/c unable to gain access to EE wells
		Event 2	5.78	13.9	3.87	75	0	10	clear, no odor
		Event 3	6.12	15.17	3.33	53	3.49	17	tan, no odor
		Event 4	4.58	18.4	2.02	*	0.9	7.91	
		Event 5	3.58	18.54	4.321	182.2	*	9.66	clear, no odor
		Event 7	4.63	16.39	3.299	210.9	2.47	48.2	Cloudy and brownish. Pump seemed to be clogged. Low flow rate.
MW-C	Edgewater	Event 1	NS	NS	NS	NS	NS	NS	NS b/c unable to gain access to EE wells
		Event 2	7.09	13.32	6.16	-252	0	3.5	grey, strong product odor
		Event 3	6.89	15.18	4.67	-148	3.34	0	clear, product odor
		Event 4	6.36	19.05	3.469	-202	*	15.3	grey, black floaties, strong product odor
		Event 5	6.18	19.18	4.619	-134.9	*	11.9	grey, product odor
		Event 7	6.55	17.93	4.449	-81.2	2.55	28.1	clear
MW-D	Edgewater	Event 1	NS	NS	NS	NS	NS	NS	NS b/c unable to gain access to EE wells
		Event 2	NS	NS	NS	NS	NS	NS	NS b/c the well is dry
		Event 3	NS	NS	NS	NS	NS	NS	NS b/c the well is dry
		Event 4	NS	NS	NS	NS	NS	NS	NS b/c the well is dry
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-E	Edgewater	Event 1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 5	6.91	18.89	1.803	-160.1	*	13.9	clear, moderate product odor

TABLE 2-6
Summary of Groundwater Water Quality Parameters
Quanta Resources Superfund Site, OU1
Edgewater, New Jersey

Sample Location	Property	Sampling Event	pH	Temp. (°C)	Cond. (mS/cm)	ORP (mV)	DO (mg/L)	Turbidity (NTU)	Comments
MW-F	Edgewater	Event 1	NS	NS	NS	NS	NS	NS	NS b/c unable to gain access to EE wells
		Event 2	7.4	14.16	3.51	-148	0	12	clear, no odor
		Event 3	7.05	15.1	3.38	-136	0	4.72	clear, no odor
		Event 4	5.94	18.6	1.814	*	0.68	5.39	clear, no odor
		Event 5	7.02	16.96	2.77	-166.8	1.66	12.9	slightly cloudy, no odor
		Event 7	7.32	14.9	3.38	-62.4	7.76	22.5	slightly clear
MW-G	Edgewater	Event 1	NS	NS	NS	NS	NS	NS	NS b/c unable to gain access to EE wells
		Event 2	6.94	11.4	3.76	10	0	6.3	clear, no odor
		Event 3	7.31	14.1	3.25	-65	3.23	0	clear, no odor
		Event 4	6.02	19.71	2.089	*	0.8	4.93	clear, no odor
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-H	Edgewater	Event 1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 5	6.46	16.77	4.948	-110.4	3.8	20.4	clear, no odor
MW-I	Edgewater	Event 1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 2	7.57	11.83	3.43	31	0.49	6.5	clear, no odor
		Event 3	7.36	13.56	0.42	68	8.35	22	tan, no odor
		Event 4	6.95	19.65	0.52	87.2	3.28	7.56	clear, no odor
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-J	Edgewater	Event 1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 2	7.16	11.1	7.49	117	3.4	4.1	clear, no odor
		Event 3	7.59	12.19	3.62	46	10.3	15	tan, no odor
		Event 4	6.39	19.89	2.73	-34.4	1.92	9.9	clear, no odor
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Tech Imp. Study	7.06	12.17	16.04	-191	0.87	1.33	light yellow, sulfur odor
MW-K	Edgewater	Event 1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 5	6.52	17.46	2.217	-145.9	*	6.35	clear, product and organic odor
MW-M	Edgewater	Event 1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 5	8.08	16.87	540.116	43.9	0.43	1.63	clear, no odor
		Tech Imp. Study	7.07	16.45	2.128	-336	0.45	2.5	clear, slight odor
MW-N-1	Edgewater	Event 1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 5	6.36	17.19	0.9118	-130	0	12.8	cloudy, no odor
		Event 7	5.98	16.49	2.22	-91.9	0.82	5.38	clear, no odor
MW-N-2	Edgewater	Event 1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 5	7.06	20.58	2.182	-176.9	1.31	16.4	clear, product odor
		Event 7	6.99	11.76	2.728	-113.6	0.79	8.38	clear, no odor
MW-N-3	Edgewater	Event 1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 5	14.47	16.19	0.545	-239	0	8.12	clear, no odor
MW-O	Edgewater	Event 1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 5	6.3	17.78	2.705	-168.9	*	3.85	clear, product and organic odor
		Event 7	6.41	16.67	4.017	-98.9	7.08	4.35	clear
MW-125	Gorge/Old River Rd	Event 7	7.15	13.71	1.268	101.9	5.11	8.6	clear
		Tech Imp. Study	7.13	11.84	1.054	61	4.21	9.45	clear, no odor
MW-126	Gorge/Old River Rd	Event 7	7.16	15.35	2.9	-170	3.89	20.7	slightly turbid
MW-4	Lever Brothers	Event 1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 4	6.29	20.32	4.1	-344.5	NS	1.76	yellow, sulfur odor
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan

TABLE 2-6
Summary of Groundwater Water Quality Parameters
Quanta Resources Superfund Site, OU1
Edgewater, New Jersey

Sample Location	Property	Sampling Event	pH	Temp. (°C)	Cond. (mS/cm)	ORP (mV)	DO (mg/L)	Turbidity (NTU)	Comments
MW-20	Lever Brothers	Event 1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 5	6.98	18.68	1.462	-99.3	*	55	clear, no odor
		Event 7	5.26	17.63	1.898	137	2.46	4.8	Slightly cloudy
		Event 1	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-22A	Lever Brothers	Event 2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 5	4.25	15.78	2.82	196	2.14	1.53	clear, no odor
		Event 1	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-29	Lever Brothers	Event 2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 4	6.06	17.95	2.7	-111	*	7.9	dark grey, sulfur odor
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 7	6.56	18.64	10.25	-334.4	0.49	1.7	Clear with black particles, odor present
MW-31	Lever Brothers	Event 1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 4	6.16	22.64	2.212	108	*	1.47	yellow, slight product odor
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-32	Lever Brothers	Event 1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 4	6.91	27.4	5.981	-324	0.69	3.18	blackish grey, slight product odor
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-36	Lever Brothers	Event 1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 4	7.06	21.12	3.74	-354	*	1.96	clear, sulfur odor
		Event 5	7.03	18.31	6.717	-374.6	*	6.53	cloudy, strong organic odor
MW-51A	Lever Brothers	Event 7	6.29	11.4	3.23	-89.6	7.1	1.62	odor present
MW-106	Lever Brothers	Event 1	6.86	18.45	3.86	-163	0	5.78	cloudy black, product odor
		Event 2	6.89	11.4	3.03	-74	1.74	3.8	clear, sulfur odor
		Event 3	7.22	12.17	9.7	-344	1	13.4	blackish grey, strong product odor
		Event 4	6.85	15.97	5.253	-320	*	2.43	grey, strong product odor
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-106A	Lever Brothers	Event 1	6.48	18.13	2.65	-132	0	2.52	grey, sulfur odor
		Event 2	6.22	12.5	2.19	-125	2.75	4.4	clear
		Event 3	6.6	12.2	2.17	-140	*	130	high turbidity
		Event 4	4.89	15.53	2.054	-31.4	1.94	1.4	grey, slight product odor
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 7	6.42	16.75	1.385	-91.8	0.79	6.9	Light grey with yellow tint, slight odor, black particles
		Event 1	4.1	17.34	3.6	146	0	3.22	clear, no odor
MW-107	Lever Brothers	Event 2	4.29	14.87	3.89	117	0.51	9.4	grey, strong product odor
		Event 3	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL
		Event 4	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 1	7.14	16.91	4.44	79	0	*	clear, product odor
MW-107A	Lever Brothers	Event 2	4.34	15.46	4.74	112	0.47	0.5	clear, strong product odor
		Event 3	4.28	13.83	4.22	140	3.38	0	clear, no odor
		Event 4	3.6	16.96	3.506	218.1	8.37	1.56	clear, product odor
		Event 5	4	16.37	*	114.3	*	1.73	clear, no odor
		Event 7	4.3	14.61	3.093	81.6	7.77	4.08	clear
		Event 1	9	13.3	1.1	-48	0	320	cloudy brown, no odor
		Event 2	8.46	14.6	0.898	14	2.07	Over Range	very turbid, silt/clay
MW-107DS	Lever Brothers	Event 3	8.28	14.8	0.841	19	1.45	110	grey/brown, cloudy
		Event 4	7.98	16.27	0.67	98.5	4.99	377	light brown, no odor
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 1	6.33	15.52	19.7	-90	6.64	23.4	grey, product odor
		Event 2	6.49	12.43	17.1	-135	2.75	60	black, strong product odor
MW-109	Lever Brothers	Event 3	7	12.53	18.8	-193	1.16	NS	clear, sulfur odor
		Event 4	4.84	19.09	15.39	-97.2	0.6	27.7	grey, murky, brown froth, tiny white worms
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 7	6.81	15.48	16.23	-161.9	0.96	26	Black color with slight oily sheen
		Tech Imp. Study	6.63	13.46	19.48	-159.4	0.85	NS	light grey, slight petroleum like odor

TABLE 2-6
Summary of Groundwater Water Quality Parameters
Quanta Resources Superfund Site, OU1
Edgewater, New Jersey

Sample Location	Property	Sampling Event	pH	Temp. (°C)	Cond. (mS/cm)	ORP (mV)	DO (mg/L)	Turbidity (NTU)	Comments
MW-109A	Lever Brothers	Event 1	7.43	9.6	3.78	-19	2.64	1.6	clear, no odor
		Event 2	7.36	8	9.35	-128	4.14	12	
		Event 3	6.97	14.4	3.02	50	1.88	21	clear, no odor
		Event 4	7.07	22.5	10.088	-213	*	2.15	tiny white worms
		Event 5	6.9	19.03	1.399	-180.4	0.32	10.55	grey, product odor
MW-115A	Lever Brothers	Event 1	NS	NS	NS	NS	NS	NS	NS b/c not yet installed
		Event 2	5.65	8.35	2.4	-98	7.68	50	clear, no odor
		Event 3	7.08	11.93	2.04	-85	6.32	29	clear
		Event 4	5.73	20.65	1.864	-80.6	4.26	1.89	tiny worms on surface, clear, slight sulfur odor
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 7	6.77	10.82	0.996	-97.8	7.87	2	clear
MW-115B	Lever Brothers	Event 1	NS	NS	NS	NS	NS	NS	NS b/c not yet installed
		Event 2	4.88	9.94	29.9	-65	4.72	72.1	clear, no odor
		Event 3	6.28	13.24	13.06	-134	1.24	28	grey, no odor
		Event 4	5.54	16.06	20.7	-90	6.83	17.7	clear, no odor
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 7	5.74	13.68	18.61	-50.3	2.52	27.8	Very slightly brown with musty odor
MW-120A	Lever Brothers	Event 1	11.15	17.85	4.33	-134	0	*	clear, strong sulfur odor
		Event 2	6.16	11.84	7.57	-37	0.46	1.9	clear
		Event 3	6.63	12.2	6.15	-111	0	11	clear, no odor
		Event 4	6.52	18.25	5.29	-273	*	0	clear, no odor
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-120B	Lever Brothers	Event 1	6.93	18.17	18.9	-333	0	*	grey, sulfur odor
		Event 2	7.08	14.1	8.65	-314	2.04	2.5	clear, sulfur odor
		Event 3	7.08	12	12.6	-348	0.33	6.3	black/grey, sulfur odor
		Event 4	6.16	15.02	0.008	-341	0.75	0	dark grey, sulfur odor
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-122A	Lever Brothers	Event 1	5.01	16.1	3.61	33	0	*	clear, product odor
		Event 2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 3	4.84	13.2	3.73	90	0	1.5	clear, gasoline odor
		Event 4	4.78	18.09	2.4	132.6	0.35	3.41	froth, product odor
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-130A	Lever Brothers	Event 7	7.4	16.32	1.14	-189	6.59	5.68	clear with trace suspended solids which give a blackish tint, odor present
MW-130B	Lever Brothers	Event 7	4.58	16.46	2.43	97.8	1.48	12.2	slightly cloudy, odor noted
MW-131	Lever Brothers	Event 7	6.39	16.21	4.68	-97.8	2.01	0.85	Clear with slight sheen
MW-132	Lever Brothers	Event 7	7.04	16.22	3.77	-310	1.31	2.27	dark black tint with a sheen, odor of rotten eggs present
MW-102	Quanta	Event 1	6.98	18.14	2.5	-302	0	10	clear, product odor
		Event 2	6.25	13.47	2.27	-338	*	3.2	dark grey, sulfur odor
		Event 3	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL
		Event 4	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-102A	Quanta	Event 1	8.1	15.06	1.45	-321	0	4.65	light tan, product odor
		Event 2	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL
		Event 3	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL
		Event 4	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-102B	Quanta	Event 1	6.25	16.75	5.11	-268	0.45	19	clear, product odor
		Event 2	6.47	13.7	5.44	-141	2.6	14.9	clear, product odor
		Event 3	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL
		Event 4	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-103	Quanta	Event 1	6.32	15.9	1.87	-365	0	9.2	clear, product odor
		Event 2	5.83	11.94	1.92	-43	0.72	23	cloudy grey, strong product odor
		Event 3	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL
		Event 4	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-103A	Quanta	Event 1	6.95	14.14	1.04	-314	0	1.8	grey, product odor
		Event 2	7.33	5.4	0.69	-216	*	1.7	clear, product odor
		Event 3	7.35	11.7	0.783	-267	2.35	3.7	clear, strong product odor
		Event 4	5.81	18.91	0.624	-304	1.18	1.3	clear, strong product odor
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 7	6.91	10.95	0.619	-280.9	0.2	0	Grey with odor
MW-103DS	Quanta	Event 1	7.51	14.22	1.07	-37	0.12	5.7	clear, no odor
		Event 2	7.86	12.2	1.11	-27	1.71	4.6	clear, no odor
		Event 3	7.59	13.1	0.979	47	0	8	clear, no odor
		Event 4	6.32	15.96	0.697	*	0.97	0.99	clear, no odor
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan

TABLE 2-6
Summary of Groundwater Water Quality Parameters
Quanta Resources Superfund Site, OU1
Edgewater, New Jersey

Sample Location	Property	Sampling Event	pH	Temp. (°C)	Cond. (mS/cm)	ORP (mV)	DO (mg/L)	Turbidity (NTU)	Comments
MW-105	Quanta	Event 1	6.47	18.21	0.676	-263	0.26	3.4	grey, strong product odor
		Event 2	7.28	9.2	0.9	-67	*	NS	
		Event 3	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL
		Event 4	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-105A	Quanta	Event 1	6.65	17.83	1.26	-281	0	1.5	clear, strong product odor
		Event 2	6.29	6.84	0.637	-269	*	3.2	clear, product odor
		Event 3	7.23	16.83	0.686	-253	1.99	0	clear, strong product odor
		Event 4	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 7	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL
MW-112A	Quanta	Event 1	10.56	17.97	3.67	-459	0	18	yellow brown, product odor
		Event 2	9.96	7.1	1.91	-130	*	*	
		Event 3	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL
		Event 4	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 7	6.99	10.42	0.305	-90.2	1.85	32.2	cloudy with black tint, slight unknown odor
MW-112B	Quanta	Event 1	6.22	19.47	6.16	-354	0.01	1.6	greenish color, product odor
		Event 2	6.25	9.59	4.58	-83	5.15	9.3	clear, product odor
		Event 3	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL
		Event 4	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 7	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL - brownish tint with a sheen floating on top
MW-113A	Quanta	Event 1	6.51	18.38	3.38	-114	0	3.13	light yellow, sulfur and petroleum odor
		Event 2	6.79	8	3.29	-113	1.94	5.3	clear, product odor
		Event 3	6.7	16.2	3.11	-74	3.7	10.8	clear, no odor
		Event 4	2.63	22.15	85.3	*	0.53	4.24	clear, no odor
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 7	6.57	12.71	2.14	-99.5	0.33	12	Slightly brownish orange with orange
MW-113B	Quanta	Event 1	4.64	18.84	3.39	156	0	12.1	yellow, cloudy
		Event 2	5.36	11.62	3.33	96	4.56	17	clear, no odor
		Event 3	4.92	13.8	3.26	115	1.74	280	cloudy white
		Event 4	1.78	18.06	2.23	*	1.03	11.2	clear, no odor
		Event 5	4.6	16.92	2.381	185.3	6.23	62.4	clear, no odor
		Event 7	4.76	14.33	1.336	174.1	6.01	70	Yellow/orange tint
MW-113C	Quanta	Event 1	4.22	13.6	3.64	180	0	7.1	clear, no odor
		Event 2	3.99	13.7	3.4	300	2.75	11	clear
		Event 3	3.77	14.4	3.17	238	0.35	0	clear
		Event 4	4.94	16.47	2.3	132	*	4.91	clear, no odor
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 7	4.95	15.22	2.462	-87.6	0.75	2.7	Clear with Sulfur odor
MW-116A	Quanta	Event 1	6.73	16.92	0.492	-377	0.34	3.7	
		Event 2	7.34	10.64	0.671	-104	*	7.6	grey, strong product odor
		Event 3	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL
		Event 4	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-116B	Quanta	Event 1	6.82	14.79	1.06	-179	1.48	15	grey, product odor
		Event 2	6.78	8.14	1.06	-94	*	4.9	clear, product odor
		Event 3	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL
		Event 4	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-116DS	Quanta	Event 1	7.32	15.22	1.85	-391	0	8.2	cloudy grey, no odor
		Event 2	7.42	13.5	1.87	-42	1.62	2	clear
		Event 3	7.78	13.94	1.78	-87	*	0	clear, no odor
		Event 4	7.33	16.59	1.54	26.8	*	1.83	grey, no odor
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-117A	Quanta	Event 1	6.51	16.77	0.426	-204	0.04	0.71	clear, product odor
		Event 2	6.87	6.6	0.458	-77	1.81	1.1	clear, strong product odor
		Event 3	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL
		Event 4	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-117B	Quanta	Event 1	6.69	17.02	0.545	-160	0.3	2.63	clear, strong product odor
		Event 2	7.38	9.82	0.554	-158	*	2.6	clear, no odor
		Event 3	7.21	13.4	0.662	-196	0	3.3	clear, product odor
		Event 4	6.25	19.7	0.483	-142	0.36	1.11	clear, slight product odor
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 7	7.53	13.75	0.522	-153.7	0.14	13	Black with black particles
		Tech Imp. Study	6.98	10.54	0.455	-109.7	1.13	2.6	Clear wight fine particles, no odor

TABLE 2-6

Summary of Groundwater Water Quality Parameters
 Quanta Resources Superfund Site, OU1
 Edgewater, New Jersey

Sample Location	Property	Sampling Event	pH	Temp. (°C)	Cond. (mS/cm)	ORP (mV)	DO (mg/L)	Turbidity (NTU)	Comments
MW-118A	Quanta	Event 1	6.61	17.07	1.19	-206	0.48	0	clear, slight product odor
		Event 2	6.79	6.9	0.571	-88	1.83	0.7	clear
		Event 3	6.92	14.8	0.53	-96	0.37	0.87	clear, no odor
		Event 4	6.43	24.2	0.68	-73.7	*	0.07	clear, product odor
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-118B	Quanta	Event 1	6.47	17.87	0.587	-133	0.26	0.94	clear, product odor
		Event 2	6.94	9.1	0.56	-72	*	4.8	clear
		Event 3	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL
		Event 4	NS	NS	NS	NS	NS	NS	NS due to presence of NAPL
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
SW-A**	Quanta	Event 1	5.46	9.8	0.432	-186	11.05	N/A	
		Event 2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
SW-B**	Quanta	Event 1	6.35	10.52	0.251	-255	12.06	N/A	
		Event 2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
SW-C**	Quanta	Event 1	7.15	12.35	0.266	-230	11.52	N/A	
		Event 2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan
SW-D**	Quanta	Event 1	7.78	12.33	0.037	-250	10.93	N/A	
		Event 2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		Event 5	NS	NS	NS	NS	NS	NS	Not in sampling plan

Notes:

Event 1: Sampling conducted November 15 to December 30, 2005

Event 2: Sampling conducted February 13 to March 15, 2006

Event 3: Sampling conducted May 15 to 24, 2006

Event 4: Sampling conducted August 14 to 20, 2006

Event 5: Sampling conducted October 23 to 27, 2006

Event 6: Sampling of temporary well points conducted June 4 to 5 2007

Event 7: Sampling conducted December 1, 2008 to January 4, 2009; wells MW-128 and MW-129 sampled March 18, 2009

Technical Impracticability Study: Sampling conducted January 8 to 13, 2009

All sampled conducted in accordance with applicable sampling plans

Parameters measured with Horiba U-22 during Events 1, 2, and 3; with a YSI-556 during Events 4, 5, and 6; and with a YSI-600XL during Event 7 and the Technical Wells with product present were not sampled during Events 3, 4, or 5

* - Results unavailable due to malfunctioning equipment

**SW - Surface water samples from seasonal standing water

Tech Imp Study - Technical Impracticability Study

mL/min - milliliters per minute

mS/cm - milliSiemens per centimeter

mV - millivolt

NS - Not sampled

NTU - Nephelometric turbidity unit

TABLE 2-7
Full Site Synoptic Water Levels - Mid-Tide - November 2008
Quanta Resources Superfund Site, OU1
Edgewater, New Jersey

Well Name	Measuring Point Elevation (ft msl)	DTW (ft)	GW Elevation (ft msl)
Shallow Unconfined Groundwater			
ACMW-1	11.29	6.84	4.45
ACMW-3	14.34	9.76	4.58
MW-101	10.63	5.72	4.91
MW-102A	9.69	4.33	5.36
MW-103A	10.03	4.18	5.85
MW-105A	8.2	6.13	2.07
MW-106A	6.65	5.65	1
MW-107A	7.04	3.71	3.33
MW-108	6.5	4.98	1.52
MW-109A	4.56	4.3	0.26
MW-111A	7.98	3.49	4.49
MW-112A	10.01	3.53	6.48
MW-113A	10.2	5.34	4.86
MW-114A	7.41	2.92	4.49
MW-115A	7.14	5.29	1.85
MW-116A	9.45	5.61	3.84
MW-117A	9.37	5.55	3.82
MW-118A	9	5.51	3.49
MW-119A	6	4.52	1.48
MW-120A	6.83	5.68	1.15
MW-121A	7.13	2.87	4.26
MW-122A	7.24	3.38	3.86
MW-130A	6.34	2.11	4.23
MW-131	6.88	4.71	2.17
MW-132	5.9	5.45	0.45
MW-133	15.38	9.76	5.62
MW-134	14.13	12.56	1.57
MW-20	15.05	10.06	4.99
MW-22A	10.35	5.65	4.7
MW-25	7.09	4.65	2.44
MW-26*	9.57	NM	NM
MW-27	7.64	4.59	3.05
MW-29	7.09	3.2	3.89
MW-30	6.27	4.69	1.58
MW-31	7.1	3.89	3.21
MW-32	6.3	3.72	2.58
MW-36	7.37	3.91	3.46
MW-36(EE)	14.14	11.32	2.82
MW-51A	7.12	4.01	3.11
MW-7	6.94	5.5	1.44
MW-A-2	17.29	12.43	4.86
MW-B	15.4	10.73	4.67
MW-C*	14.75	NM	NM
MW-D	15.27	10.62	4.65
MW-E*	14.96	NM	NM
MW-F	11.29	9.71	1.58
MW-G	13.91	9.79	4.12
MW-H	19.36	13.42	5.94
MW-I*	19.13	NM	NM
MW-J	16.09	13.05	3.04
MW-K*	13.92	NM	NM
MW-L	15.05	10.08	4.97
MW-M	15.56	11.22	4.34

Well Name	Measuring Point Elevation (ft msl)	DTW (ft)	GW Elevation (ft msl)
Shallow Unconfined Groundwater			
MW-N-2	11.42	5.5	5.92
MW-O	15.51	12.1	3.41
PZ-6S	5.72	3.52	2.2
PZ-7S	5.71	4.19	1.52
PZ-8S	4.46	2.55	1.91
MW-123	5.54	2.71	2.83
MW-124	7.48	4.48	3
MW-125*	11.97	NM	NM
MW-126	13.87	8.99	4.88
MW-127	6.35	3.7	2.65
MW-136	5.02	1.85	3.17
Deeper Unconfined Groundwater			
DMW-2	14.14	11.2	2.94
MW-102	9.24	4.62	4.62
MW-102B	9.61	5.02	4.59
MW-103	8.57	3.92	4.65
MW-104R	9.11	5.5	3.61
MW-105	7.87	5.96	1.91
MW-106	7.13	6.13	1
MW-107	6.84	2.84	4
MW-109	4.49	6.14	-1.65
MW-111B	7.85	3.69	4.16
MW-112B	9.6	4.2	5.4
MW-113B	9.94	5.11	4.83
MW-113C	9.8	5.12	4.68
MW-114B	7.24	2.83	4.41
MW-115B	6.7	2.8	3.9
MW-116B	8.69	5	3.69
MW-116DS	9.18	4.88	4.3
MW-117B	9.04	5.23	3.81
MW-118B	9.4	7.11	2.29
MW-119B	5.68	4.26	1.42
MW-120B	6.78	5.7	1.08
MW-121B	7.16	2.7	4.46
MW-130B	6.47	2.27	4.2
MW-135	15	12.18	2.82
MW-A-1	16.06	11.13	4.93
MW-N-1	12	7.12	4.88
PZ-6I	5.74	2.22	3.52
PZ-7D	5.69	1.88	3.81
PZ-7I	5.66	3.4	2.26
PZ-8I	4.39	0.32	4.07
Deep Sand Unit			
MW-101DS	10.45	5.57	4.88
MW-103DS	10.13	5.33	4.8
MW-107DS	6.82	2.88	3.94
MW-37D	7	1.94	5.06
PZ-8D	4.53	0.05	4.48
Bedrock Well			
MW-N-3	13.34	8.56	4.78
PZ-6D	5.79	1.89	3.9
Tidal Gauge			
TGS-1	12.58	10.75	1.83

Notes:

* - Monitoring well not accessible

Shallow unconfined groundwater - Well screen set at or near the water table
Deeper unconfined groundwater - Well screen set at silty-clay aquitard
Deep sand - Well screen set below silty-clay aquitard
Bedrock - Well screen set in bedrock

Depth to water measurements reported in feet below top of inner monitoring well casing or "measuring point".
Depth to water measurements taken during mid tide on November 25, 2008.

DTW - depth to water
ft msl - Feet referenced to mean sea level
NM - Not measured

Vertical datum: NAVD 88

TABLE 2-8
 NAPL Measurements
Quanta Resources Superfund Site, OU1
Edgewater, New Jersey

Hydro-stratigraphic Unit	Well	Northing	Easting	Measuring Point Elevation (ft msl)	NAPL Thickness (ft)						
					Dec-05	Mar-06	May-06	Aug-06	Nov-08	Feb-09	Mar-09
SHALLOW UNCONFINED GROUNDWATER	ACMW-1	719343.72	633428.46	11.29	NM	NM	NM	NM	ND	NM	NM
	ACMW-3	719119.21	633543.67	14.34	NM	NM	NM	NM	ND	NM	NM
	MW-101	719001.17	632734.82	10.63	NM	ND	ND	ND	ND	NM	NM
	MW-102A	718774.51	632942.16	9.69	NM	4	5	6.5	6.95	NM	NM
	MW-103A	718607.48	633205.75	10.03	NM	ND	ND	ND	3.21	NM	NM
	MW-105A	718414.17	633552.17	8.20	NM	1	ND	0.08 (LNAPL)	0.31 (LNAPL) 10.3	NM	NM
	MW-106A	718187.85	633438.50	6.65	NM	ND	ND	ND	ND	NM	NM
	MW-107A	718371.31	632973.74	7.04	NM	ND	ND	ND	ND	NM	NM
	MW-108	718613.20	632760.11	6.50	NM	NM	ND	ND	ND	NM	NM
	MW-109A	718064.11	633349.26	4.56	NM	ND	ND	ND	ND	NM	NM
	MW-111A	719186.92	632597.85	7.98	NM	ND	ND	ND	ND	NM	NM
	MW-112A	718954.83	633038.93	10.01	NM	ND	0.2	0.21	Trace	NM	NM
	MW-113A	718887.05	633231.50	10.20	NM	ND	ND	ND	ND	NM	NM
	MW-114A	718640.09	633028.45	7.41	NM	ND	ND	ND	NM	Trace	NM
	MW-115A	718206.33	632949.42	7.14	NM	ND	ND	ND	ND	NM	NM
	MW-116A	718564.88	633607.66	9.45	NM	ND	0.16	0.58	0.80	NM	NM
	MW-117A	718495.52	633575.22	9.37	NM	0.25	2	0.17	0.20	NM	NM
	MW-118A	718454.55	633573.47	9.00	NM	ND	ND	ND	ND	NM	NM
	MW-119A	718343.86	633523.03	6.00	NM	ND	ND	NM	NM	ND	NM
	MW-120A	718212.64	633495.32	6.83	NM	ND	ND	ND	ND	NM	NM
	MW-121A	718455.01	633276.03	7.13	NM	ND	ND	ND	NM	Trace	NM
	MW-122A	718339.41	632953.13	7.24	NM	ND	ND	ND	ND	ND	NM
	MW-128	718828.53	632458.81	6.35	NI	NI	NI	NI	NI	NI	ND
	MW-129	719191.81	632438.65	8.69	NI	NI	NI	NI	NI	NI	ND
	MW-130A	718485.12	633029.60	6.34	NI	NI	NI	NI	ND	NM	NM
	MW-131	718179.94	633097.72	6.88	NI	NI	NI	NI	ND	NM	NM
	MW-132	718079.22	633160.00	5.90	NI	NI	NI	NI	Trace	NM	0.55
	MW-133	718804.18	633478.47	15.38	NI	NI	NI	NI	ND	NM	NM
	MW-134	718686.21	633687.67	14.13	NI	NI	NI	NI	ND	NM	ND
	MW-20	718848.78	633445.86	15.05	NM	NM	NM	NM	ND	NM	NM
	MW-22A	719250.48	633323.31	10.35	NM	NM	NM	NM	ND	NM	NM
	MW-25	717917.29	633037.60	7.09	NM	NM	NM	ND	ND	NM	NM
	MW-26	718129.00	632410.41	9.57	NM	NM	NM	ND	ND	NM	NM
	MW-27	718579.00	632747.00	7.64	NM	NM	NM	NM	ND	NM	NM
	MW-29	718363.77	633048.64	7.09	NM	NM	NM	ND	ND	NM	NM
	MW-30	718116.46	633203.41	6.27	NM	NM	NM	ND	ND	NM	NM
	MW-31	718314.63	632901.03	7.10	NM	NM	NM	ND	ND	NM	NM
	MW-32	718128.49	632889.70	6.30	NM	NM	NM	ND	ND	NM	NM

TABLE 2-8
 NAPL Measurements
Quanta Resources Superfund Site, OU1
Edgewater, New Jersey

Hydro-stratigraphic Unit	Well	Northing	Easting	Measuring Point Elevation (ft msl)	NAPL Thickness (ft)						
					Dec-05	Mar-06	May-06	Aug-06	Nov-08	Feb-09	Mar-09
SHALLOW UNCONFINED GROUNDWATER	MW-36	718126.26	632759.61	7.37	NM	NM	NM	ND	ND	NM	NM
	MW-36(E)	719166.24	633686.59	14.14	NM	NM	NM	NM	ND	NM	NM
	MW-51A	718216.00	633042.00	7.12	NM	NM	NM	NM	ND	NM	NM
	MW-7	718272.56	633298.50	6.94	NM	NM	NM	NM	0.20 (LNAPL)	NM	NM
	MW-A-2	719104.51	633164.73	17.29	NM	ND	ND	ND	ND	NM	NM
	MW-B	718860.98	633388.94	15.40	NM	ND	ND	ND	ND	NM	NM
	MW-C	718703.23	633651.85	14.75	NM	ND	ND	ND	ND	NM	NM
	MW-D	719033.11	633512.16	15.27	NM	ND	ND	ND	ND	NM	NM
	MW-E	718829.23	633581.44	14.96	NM	NM	NM	NM	ND	NM	NM
	MW-F	718804.86	633811.88	11.29	NM	ND	ND	ND	ND	NM	NM
	MW-G	719310.72	633353.87	13.91	NM	ND	ND	ND	ND	NM	NM
	MW-H	719245.98	633478.25	19.36	NM	NM	NM	NM	ND	NM	NM
	MW-I	719078.28	633801.55	19.13	NM	ND	ND	ND	ND	NM	NM
	MW-J	718920.09	634110.90	16.09	NM	ND	ND	ND	ND	NM	NM
	MW-K	719274.51	633815.30	13.92	NM	NM	NM	NM	ND	NM	NM
	MW-L	719301.42	632947.29	15.05	NM	ND	ND	ND	ND	NM	NM
	MW-M	719607.39	633150.46	15.56	NM	NM	NM	NM	ND	NM	NM
	MW-N-2	719157.71	633037.37	11.42	NM	NM	NM	NM	ND	NM	NM
	MW-O	718746.51	633563.10	15.51	NM	NM	NM	NM	ND	NM	NM
	PZ-6S	718579.95	633648.02	5.72	NI	NI	NI	NI	ND	NM	NM
	PZ-7S	718511.80	633625.02	5.71	NI	NI	NI	NI	ND	NM	NM
	PZ-8S	718374.96	633554.42	4.46	NI	NI	NI	NI	ND	NM	NM
	MW-123	718728.96	632591.99	5.54	NI	NI	NI	NI	14.20	NM	NM
	MW-124	718620.61	632423.84	7.48	NI	NI	NI	NI	ND	NM	NM
	MW-125	719375.31	632626.42	11.97	NI	NI	NI	NI	ND	NM	NM
	MW-126	719166.66	632793.59	13.87	NI	NI	NI	NI	ND	NM	ND
	MW-127	718828.53	632458.81	6.35	NI	NI	NI	NI	ND	NM	NM
	MW-136	718854.68	632600.74	5.02	NI	NI	NI	NI	Trace	NM	<0.1

TABLE 2-8
NAPL Measurements
Quanta Resources Superfund Site, OU1
Edgewater, New Jersey

Hydro-stratigraphic Unit	Well	Northing	Easting	Measuring Point Elevation (ft msl)	NAPL Thickness (ft)						
					Dec-05	Mar-06	May-06	Aug-06	Nov-08	Feb-09	Mar-09
DEEPER UNCONFINED GROUNDWATER	DMW-2	719172.49	633688.59	14.14	NM	NM	NM	NM	ND	NM	NM
	MW-102	718774.26	632941.80	9.24	NM	0.2	2.1	2.17	1.35	NM	NM
	MW-102B	718766.25	632931.53	9.61	NM	1.5	0.33	0.25	3.00	NM	NM
	MW-103	718633.11	633224.04	8.57	NM	1	1	ND	1.40	NM	NM
	MW-104R	718519.79	633611.94	9.11	NM	0.2	0.16	ND	0.25	NM	NM
	MW-105	718420.92	633568.90	7.87	NM	5.5	ND	NM	9.80	NM	NM
	MW-106	718216.29	633448.63	7.13	NM	ND	ND	ND	ND	NM	NM
	MW-107	718396.33	633001.00	6.84	NM	1.4	1.1	ND	4.10	NM	NM
	MW-109	718060.47	633348.35	4.49	NM	ND	ND	ND	ND	NM	NM
	MW-111B	719195.22	632596.28	7.85	NM	ND	ND	ND	ND	NM	NM
	MW-112B	718965.16	633046.35	9.60	NM	1.8	2	3	6.95	NM	NM
	MW-113B	718891.63	633233.93	9.94	NM	ND	ND	ND	ND	NM	NM
	MW-113C	718899.82	633232.35	9.80	NM	ND	ND	ND	ND	NM	NM
	MW-114B	718646.47	633018.97	7.24	NM	ND	ND	ND	NM	Trace	NM
	MW-115B	718209.64	632951.58	6.70	NM	ND	ND	ND	ND	NM	NM
	MW-116B	718564.00	633614.00	8.69	NM	6.5	3.5	11.5	12.74	NM	NM
	MW-116DS	718555.99	633613.65	9.18	NM	ND	ND	ND	ND	NM	NM
	MW-117B	718490.38	633577.94	9.04	NM	ND	ND	ND	ND	NM	NM
	MW-118B	718443.68	633572.99	9.40	NM	0.08	0.25	0.25	1.83	NM	NM
	MW-119B	718355.51	633526.26	5.68	NM	ND	ND	ND	NM	ND	NM
	MW-120B	718223.61	633484.98	6.78	NM	ND	ND	ND	ND	NM	NM
	MW-121B	718457.53	633272.15	7.16	NM	ND	0.16	0.25	NM	0.42	NM
	MW-130B	718487.18	633030.76	6.47	NI	NI	NI	NI	ND	NM	NM
	MW-135	718635.16	633660.04	15.00	NI	NI	NI	NI	0.80	NM	NM
	MW-A-1	719111.78	633144.36	16.06	NM	ND	ND	ND	ND	NM	NM
	MW-N-1	719148.72	633040.28	12.00	NM	NM	NM	NM	ND	NM	NM
	PZ-6I	718579.95	633648.02	5.74	NI	NI	NI	NI	ND	NM	NM
	PZ-7D	718511.80	633625.02	5.69	NI	NI	NI	NI	ND	NM	NM
	PZ-7I	718511.80	633625.02	5.66	NI	NI	NI	NI	ND	NM	NM
	PZ-8I	718374.96	633554.42	4.39	NI	NI	NI	NI	ND	NM	NM

TABLE 2-8
 NAPL Measurements
Quanta Resources Superfund Site, OU1
Edgewater, New Jersey

Hydro-stratigraphic Unit	Well	Northing	Easting	Measuring Point Elevation (ft msl)	NAPL Thickness (ft)						
					Dec-05	Mar-06	May-06	Aug-06	Nov-08	Feb-09	Mar-09
DEEP SAND	MW-101DS	719004.98	632748.11	10.45	NM	ND	ND	ND	ND	NM	NM
	MW-103DS	718609.96	633208.63	10.13	NM	ND	ND	ND	ND	NM	NM
	MW-107DS	718369.21	632986.22	6.82	NM	ND	ND	ND	ND	NM	NM
	MW-37D	718578.69	632724.75	7.00	NM	NM	NM	NM	ND	NM	NM
	PZ-8D	718374.96	633554.42	4.53	NI	NI	NI	NI	ND	NM	NM
BEDROCK	MW-N-3	719133.67	633089.76	13.34	NM	NM	NM	NM	ND	NM	NM
	PZ-6D	718579.95	633648.02	5.79	NI	NI	NI	NI	ND	NM	NM
TIDAL GAUGE	TGS-1	718038.01	633937.21	12.58	NI	NI	NI	NI	ND	NM	NM

Notes:

Measurements shown are of dense non-aqueous phase liquid (DNAPL) unless noted as light non-aqueous phase liquid (LNAPL).

ft msl - Feet referenced to mean sea level, NAVD 88

NM = not measured

ND = not detected

NI = not installed. Monitoring well was installed at a later date

Trace = unmeasurable amount of NAPL is noted on the interface probe.

Shallow unconfined groundwater - Monitoring well screen generally set at or near the water table

Deeper unconfined groundwater- Monitoring well screen set above silty-clay aquitard

Deep sand - Monitoring well screened below silty-clay aquitard

Bedrock - Monitoring well screen set in the bedrock

TABLE 2-9
OU1/OU2 Shoreline Water Levels - December 2008
Quanta Resources Superfund Site
Edgewater, New Jersey

Well Name	Measuring Point TIC Elevation (ft msl)	December 5, 2008				December 6, 2008				December 7, 2008				December 11, 2008				December 12, 2008				December 13, 2008						
		High Tide		Low Tide		High Tide		Low Tide		High Tide		Low Tide		High Tide		Low Tide		High Tide		Mid Tide		Low Tide		High Tide		Low Tide		
		DTW (ft)	GW Elevation (ft msl)	DTW (ft)	GW Elevation (ft msl)	DTW (ft)	GW Elevation (ft msl)	DTW (ft)	GW Elevation (ft msl)	DTW (ft)	GW Elevation (ft msl)	DTW (ft)	GW Elevation (ft msl)	DTW (ft)	GW Elevation (ft msl)	DTW (ft)	GW Elevation (ft msl)	DTW (ft)	GW Elevation (ft msl)	DTW (ft)	GW Elevation (ft msl)	DTW (ft)	GW Elevation (ft msl)	DTW (ft)	GW Elevation (ft msl)	DTW (ft)	GW Elevation (ft msl)	
Shallow Unconfined Groundwater																												
ACMW-1	11.29	NM	NM	NM	NM	6.97	4.32	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	6.44	4.85	6.35	4.94	NM	NM	
ACMW-3	14.34	NM	NM	NM	NM	9.92	4.42	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	8.63	5.71	9.36	4.98	NM	NM	
MW-101	10.63	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	
MW-102A	9.69	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	3.32	6.37	3.53	6.16	NM	NM	
MW-103A	10.03	4.38	5.65	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	4.29	5.74	NM	NM	NM	NM	3.68	6.35	3.82	6.21	3.83	6.2	
MW-105A	8.2	13.5*	-5.3	9.5*	-1.3	6.35	1.85	6.2	2	6.68	1.52	6.45	1.75	6.3	1.9	6.19	2.01	4.77	3.43	5.31	2.89	5.75	2.45	5.16	3.04	5.51	2.69	
MW-106A	6.65	5.93	NM	6.16	0.49	6.17	0.48	6.25	0.4	6.45	0.2	6.15	0.5	6.08	0.57	6	0.65	4.82	1.83	4.24	2.41	4.49	2.16	4.91	1.74	5.02	1.63	
MW-107A	7.04	4.73	2.31	3.68	3.36	3.69	3.35	3.68	3.36	3.71	3.33	3.68	3.36	NM	NM	3.78	3.26	2.89	4.15	NM	NM	2.99	4.05	3.18	3.86	3.17	3.87	
MW-108	6.5	4.31	2.19	NM	NM	4.31	2.19	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	3.9	2.6	4.01	2.49	
MW-109A	4.56	4.77	-0.21	6.1	-1.54	4.02	0.54	5.59	-1.03	4.31	0.25	5.39	-0.83	3.24	1.32	5.76	-1.2	NM	NM	2.88	1.68	5.53	-0.97	2.75	1.81	6.15	-1.59	
MW-112A	10.01	5.4	4.61	NM	NM	4.75	5.26	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	4.6	5.41	3.7	6.31	NM	NM	
MW-113A	10.2	NM	NM	NM	NM	5.41	4.79	NM	NM	NM	NM	NM	NM	NM	NM	5.34	4.86	NM	NM	NM	NM	4.69	5.51	4.83	5.37	4.8	5.4	
MW-114A	7.41	NM	NM	NM	NM	3.1	4.31	NM	NM	3.21	4.2	NM	NM	NM	NM	NM	NM	2.82	4.59	NM	NM	NM	NM	2.65	4.76	2.55	4.86	
MW-115A	7.14	5.17	1.97	5.25	1.89	5.22	1.92	5.21	1.93	5.27	1.87	5.24	1.9	NM	NM	6.19	0.95	NM	NM	NM	NM	NM	NM	3.9	3.24	2.63	4.51	
MW-116A	9.45	5.51	3.94	5.54	3.91	5.56	3.89	5.59	3.86	5.66	3.79	5.59	3.86	5.92	3.53	5.76	3.69	4.3	5.15	4.49	4.96	4.13	5.32	4.32	5.13	4.35	5.1	
MW-117A	9.37	5.36	4.01	5.39	3.98	5.45	3.92	5.52	3.85	5.51	3.86	4.45	4.92	5.69	3.68	5.67	3.7	3.66	5.71	3.64	5.73	3.96	5.41	4.27	5.1	4.27	5.1	
MW-118A	9	5.5	3.5	5.46	3.54	5.51	3.49	5.53	3.47	5.56	3.44	5.52	3.48	5.45	3.55	5.61	3.39	4	5	4.1	4.9	4.23	4.77	4.48	4.52	4.56	4.44	
MW-119A	6	5.19	0.81	5.12	0.88	5.11	0.89	5.15	0.85	5.12	0.88	5.06	0.94	5.13	0.87	4.99	1.01	2.65	3.35	NM	NM	3.71	2.29	4.1	1.9	4.1	1.9	
MW-120A	6.83	6.14	0.69	6.3	0.53	6.19	0.64	6.27	0.56	6.21	0.62	6.21	0.62	5.99	0.84	6.18	0.65	4.32	2.51	4.39	2.44	4.7	2.13	4.9	1.93	5.15	1.68	
MW-121A	7.13	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	2.75	4.38	2.71	4.42	NM	NM	2.69	4.44	2.69	4.44	2.75	4.38	
MW-122A	7.24	NM	NM	3.49	3.75	3.4	3.84	3.44	3.8	3.49	3.75	3.35	3.89	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	3.15	4.09	3.19	4.05	
MW-130A	6.34	2.94	3.4	2.75	3.59	2.11	4.23	2.17	4.17	2.2	4.14	2.06	4.28	2.26	4.08	2.17	4.17	1.51	4.83	NM	NM	1.61	4.73	1.76	4.58	1.75	4.59	
MW-131	6.88	4.71	2.17	6.07	0.81	4.7	2.18	4.7	2.18	4.72	2.16	4.71	2.17	4.75	2.13	4.74	2.14	4.2	2.68	NM	NM	3.99	2.89	4.1	2.78	4.15	2.73	
MW-132	5.9	4.95	0.95	5.29	0.61	4.77	1.13	5.27	0.63	5.2	0.7	5.3	0.6	4.27	1.63	5.31	0.59	1.86	4.04	4.08	1.82	5.8	0.1	3.49	2.41	5.6	0.3	
MW-133	15.38	NM	NM	NM	NM	10.7	4.68	10.82	4.56	NM	NM	NM	NM	NM	NM	10.82	4.56	10.23	5.15	NM	NM	10.13	5.25	10.05	5.33	10.16	5.22	
MW-134	14.13	13.5	0.63	14.08	0.05	13.45	0.68	13.96	0.17	13.52	0.61	13.71	0.42	12.76	1.37	13.4	0.73	11.15	2.98	12.2	1.93	12.88	1.25	12.19	1.94	13.3	0.83	
MW-20	15.05	NM	NM	NM	NM	10.46	4.59	11.5	3.55	NM	NM	NM	NM	NM	NM	9.02	6.03	NM	NM	NM	NM	9.78	5.27	9.77	5.28	9.75	5.3	
MW-22A	10.35	NM	NM	NM	NM	5.76	4.59	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	5.12	5.23	NM	NM	NM	NM	
MW-25	7.09	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	4.76	2.33	4.63	2.46	2.98	4.11	3.06	4.03	3.2	3.89	3.8	3.29	3.98	3.11
MW-27	7.64	4.58	3.06	4.58	3.06	4.6	3.04	4.6	3.04	4.61	3.03	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	4.13	3.51	4.15	3.49	
MW-29	7.09	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	3.15	3.94	2.66	4.43	NM	NM	2.39	4.7	2.86	4.23	2.85	4.24	
MW-30	6.27	4.58	1.15	6.43	-0.16	5.17	1.1	5.37	0.9	5.25	1.02	5.35	0.92	4.96	1.31	5.2	1.07	2.56	3.71	4.45	1.82	4.45	1.82	4.55	1.72	4.75	1.52	
MW-32	6.3	3.66	2.64	4.68	1.62	3.73	2.57	3.69	2.61	3.73	2.57	3.65	2.65	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	3.21	3.09	3.22	3.08	
MW-36	7.37	3.46	3.91	4.9	2.47	3.44	3.93	3.45	3.92	3.52	3.85	3.45	3.92	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	4.1	3.27	2.98	4.39	
MW-36(EE)	14.14	NM	NM	NM	NM	11.38	2.76	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	10.03	4.11	NM	NM	NM	NM	
MW-51A	7.12	4.56	2.56	4.46	2.66	3.96	3.16	3.93	3.19	3.99	3.13	3.98	3.14	NM	NM	4.09	3.03	3.04	4.08	5.72	1.4	3.09	4.03	3.3	3.82	3.32	3.8	
MW-7	6.94	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	5.85	1.09	4.42	2.52	NM	NM	4.81	2.13	5.5	1.44	5.7	1.24	
MW-A-2	17.29	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	12.08	5.21	NM	NM	NM	NM	
MW-B	15.4	NM	NM	NM	NM	10.71	4.69	10.75	4.65	NM	NM	NM	NM	NM	NM	10.75	4.65	NM	NM	NM	NM	10.2	5.2	10.11	5.29	10.1	5.3	
MW-C	14.75	NM	NM	NM	NM	13.04	1.71	13.03	1.72	NM	NM	NM	NM	12.45	2.3	12.96	1.79	11.23	3.52	12.2	2.55	12.36	2.39	12.25	2.5	12.33	2.42	
MW-D	15.27	NM	NM	NM	NM	10.86	4.41	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM										

TABLE 2-9
OU1/OU2 Shoreline Water Levels - December 2008
Quanta Resources Superfund Site
Edgewater, New Jersey

Well Name	Measuring Point TIC Elevation (ft msl)	December 5, 2008				December 6, 2008				December 7, 2008				December 11, 2008				December 12, 2008						December 13, 2008			
		High Tide		Low Tide		High Tide		Low Tide		High Tide		Low Tide		High Tide		Low Tide		High Tide		Mid Tide		Low Tide		High Tide		Low Tide	
		DTW (ft)	GW Elevation (ft msl)	DTW (ft)	GW Elevation (ft msl)	DTW (ft)	GW Elevation (ft msl)	DTW (ft)	GW Elevation (ft msl)	DTW (ft)	GW Elevation (ft msl)	DTW (ft)	GW Elevation (ft msl)	DTW (ft)	GW Elevation (ft msl)	DTW (ft)	GW Elevation (ft msl)	DTW (ft)	GW Elevation (ft msl)	DTW (ft)	GW Elevation (ft msl)	DTW (ft)	GW Elevation (ft msl)	DTW (ft)	GW Elevation (ft msl)	DTW (ft)	GW Elevation (ft msl)
Deeper Unconfined Groundwater																											
DMW-2	14.14	NM	NM	NM	NM	11.28	2.86	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	9.97	4.17	NM	NM	NM	NM
MW-102	9.24	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	4.11	5.13	4.26	4.98	NM	NM
MW-102B	9.61	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	4.52	5.09	4.67	4.94	NM	NM
MW-103	8.57	3.97	4.6	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	4	4.57	NM	NM	NM	NM	3.43	5.14	3.52	5.05	3.51	5.06
MW-103B	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	4.46	N/A	NM	NM	NM	NM	NM	NM	NM	NM
MW-104R	9.11	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	5.25	3.86	5.21	3.9	4.08	5.03	4.07	5.04	4.61	4.5	5.71	3.4	5.9	3.21
MW-105	7.87	6.9	0.97	6.11	1.76	6.06	1.81	6.12	1.75	6.13	1.74	6.07	1.8	6.05	1.82	6.11	1.76	4.23	3.64	4.97	2.9	5.37	2.5	5	2.87	5.46	2.41
MW-106	7.13	6.4	0.73	6.45	0.68	6.47	0.66	6.49	0.64	6.15	0.98	6.45	0.68	6.49	0.64	NM	NM	5.26	1.87	4.71	2.42	4.93	2.2	5.18	1.95	5.3	1.83
MW-107	6.84	3.03	3.81	2.96	3.88	2.85	3.99	2.91	3.93	2.93	3.91	2.34	4.5	3.03	3.81	2.95	3.89	2.29	4.55	NM	NM	2.42	4.42	2.61	4.23	2.6	4.24
MW-109	4.49	6.71	-2.22	7.1	-2.61	6.1	-1.61	6.46	-1.97	6.11	-1.62	6.45	-1.96	7.55	-3.06	7.14	-2.65	NM	NM	6.77	-2.28	6.57	-2.08	6.2	-1.71	6.3	-1.81
MW-112B	9.6	NM	NM	NM	NM	4.46	5.14	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	3.45	6.15	3.75	5.85	NM	NM
MW-113B	9.94	5.19	4.75	NM	NM	5.15	4.79	NM	NM	NM	NM	NM	NM	NM	NM	5.1	4.84	NM	NM	NM	NM	4.45	5.49	4.57	5.37	4.6	5.34
MW-113C	9.8	NM	NM	NM	NM	5.21	4.59	NM	NM	NM	NM	NM	NM	NM	NM	5.19	4.61	NM	NM	NM	NM	4.55	5.25	4.57	5.23	4.6	5.2
MW-114B	7.24	NM	NM	NM	NM	2.93	4.31	NM	NM	2.93	4.31	NM	NM	NM	NM	NM	NM	2.3	4.94	NM	NM	NM	NM	2.4	4.84	2.47	4.77
MW-115B	6.7	2.91	3.79	3.05	3.65	2.94	3.76	2.91	3.79	3	3.7	3.05	3.65	NM	NM	3.92	2.78	NM	NM	NM	NM	NM	NM	2.59	4.11	4	2.7
MW-116B	8.69	4.97	3.72	4.98	3.71	4.99	3.7	5.04	3.65	5.05	3.64	4.99	3.7	5.25	3.44	5.15	3.54	3.58	5.11	3.19	5.5	3.23	5.46	4.39	4.3	3.41	5.28
MW-116DS	9.18	4.81	4.37	5.31	3.87	4.82	4.36	5.32	3.86	4.99	4.19	5.22	3.96	4.83	4.35	5.42	3.76	3.72	5.46	NM	NM	4.89	4.29	4.08	5.1	4.95	4.23
MW-117B	9.04	5.14	3.9	5.16	3.88	5.11	3.93	5.25	3.79	5.28	3.76	5.21	3.83	8.85	0.19	5.36	3.68	3.45	5.59	3.61	5.43	3.72	5.32	3.99	5.05	4.03	5.01
MW-118B	9.4	7.4	2	7.41	1.99	7.41	1.99	7.5	1.9	7.51	1.89	7.41	1.99	7.35	2.05	7.17	2.23	5.4	4	6.04	3.36	6.28	3.12	6.36	3.04	6.48	2.92
MW-119B	5.68	4.85	0.83	4.88	0.8	4.87	0.81	4.9	0.78	4.85	0.83	4.79	0.89	4.84	0.84	4.73	0.95	2.49	3.19	NM	NM	3.45	2.23	3.67	2.01	3.85	1.83
MW-120B	6.78	6.04	0.74	6.12	0.66	6.09	0.69	6.54	0.24	6.08	0.7	6.08	0.7	6.14	0.64	6.11	0.67	4.83	1.95	4.35	2.43	4.57	2.21	4.82	1.96	5	1.78
MW-121B	7.16	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	2.71	4.45	2.4	4.76	NM	NM	2.33	4.83	2.41	4.75	2.4	4.76
MW-130B	6.47	3	3.47	2.77	3.7	2.32	4.15	2.29	4.18	2.35	4.12	2.31	4.16	2.48	3.99	2.39	4.08	2.18	4.29	NM	NM	2.04	4.43	2.06	4.41	2.05	4.42
MW-135	15	12.4	2.6	12.54	2.46	12.39	2.61	12.6	2.4	12.5	2.5	12.49	2.51	12.03	2.97	12.93	2.07	11.65	3.35	11.96	3.04	12.09	2.91	11.54	3.46	12.15	2.85
MW-A-1	16.06	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	10.44	5.62	NM	NM	NM	NM
MW-N-1	12	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	6.57	5.43	NM	NM	NM	NM
PZ-6I	5.74	2.06	3.68	2.95	2.79	2.23	3.51	2.71	3.03	2.42	3.32	2.35	3.39	1.79	3.95	2.63	3.11	0.69	5.05	2.05	3.69	2.51	3.23	1.36	4.38	2.53	3.21
PZ-7D	5.69	1.35	4.34	1.93	3.76	1.85	3.84	1.95	3.74	1.72	3.97	1.75	3.94	1.27	4.42	2.08	3.61	1.12	4.57	1.07	4.62	1.76	3.93	1.09	4.6	1.5	4.19
PZ-7I	5.66	3.41	2.25	3.36	2.3	3.55	2.11	3.54	2.12	3.46	2.2	3.5	2.16	3.56	2.1	3.59	2.07	3.58	2.08	3.48	2.18	3.45	2.21	3.45	2.21	3.5	2.16
PZ-8I	4.39	0**	4.39	3.5	0.89	0.1	4.29	0.2	4.19	0.4	3.99	0.5	3.89	0**	4.39	0.2	4.19	0**	4.39	0**	4.39	0.2	4.19	0**	4.39	0.1	4.29
Deep Sand Unit																											
MW-103DS	10.13	5.39	4.74	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	5.77	4.36	NM	NM	NM	NM	5.02	5.11	4.61	5.52	5.15	4.98
MW-107DS	6.82	2.51	4.31	2.44	4.38	2.27	4.55	2.24	4.58	2.32	4.5	2.29	4.53	NM	NM	2.31	4.51	1.61	5.21	NM	NM	1.6	5.22	1.52	5.3	1.55	5.27
MW-37D	7	1.94	5.06	1.94	5.06	1.95	5.05	2.02	4.98	2.03	4.97	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	1.15	5.85	1.25	5.75
PZ-8D	4.53	0**	4.53	0.15	4.38	0.1	4.43	0.4	4.13	0**	4.53	0.3	4.23	0**	4.53	0.86	3.67	0.01	4.52	1.02	3.51	0.2	4.33	0**	4.53	1.9	2.63
Bedrock Well																											
MW-N-3	13.34	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	7.94	5.4	NM	NM	NM	NM
PZ-6D	5.79	1.75	4.04	3.19	2.6	1.75	4.04	2.35	3.44	1.95	3.84	2.11	3.68	3.44	2.35	2.45	3.34	0.97	4.82	1.29	4.5	1.91	3.88	1.04	4.75	1.91	3.88
Tidal Gauge																											
TGS-1	12.58	10.4	2.18	12.12	0.46	10.5	2.08	12.82	-0.24	11.09	1.49	12.78	-0.2	9.28	3.3	13.72	-1.14	7.26	5.32	10.64	1.94	13.65	-1.07	9.24	3.34	13.62	-1.04
OU2 Piezometers																											
PZ-1D	4.11	2.1	2.01	2.2	1.91	2.3	1.81	2.4	1.71	2	2.11	2.1	2.01	2	2.11	2	2.11	NM	NM	1.2	2.91	1.6	2.51	2	2.11	2.2	1.91
PZ-1I	4.24	2.9	1.34	3.02	1.22	2.9	1.34	3.03	1.21	2.8	1.44	2.9	1.34	2.5	1.74	2.7	1.54	NM	NM	2.8	1.44	3	1.24	2.4	1.84	2.9	1.34
PZ-1S	3.71	3.6	0.11	4.2	-0.49	3.7	0.01	3.85	-0.14	3.7	0.01	3.9	-0.19	3.8	-0.09	3.9	-0.19	NM	NM	3.6	0.11	3.5	0.21	2.9	0.81	3.9	-0.19
PZ-2D	8.56	4.93	3.63	4.81	3.75	4.9	3.66	4.95	3.61	4.6	3.96	4.2	4.36	4.3	4.26	3.75	4.81	3.1	5.46	3.1	5.46	3.1	5.46	3.1	5.46	3.1	5.46
PZ-2I	8.3	5.95	2.35	6.19	2.11	5.9	2.4	6.2	2.1	4.7	3.6	5.9	2.4	5.4	2.9	6.05	2.25	4.8	3.5	5	3.3	5.9	2.4	5.5	2.8	6.2	2.1
PZ-2S	8.24	6.2	2.04	8.07	0.17	6.6	1.64	7.91																			

TABLE 2-10
Summary of NAPL Samples and Analyses
Quanta Resources Superfund Site, OU1
Edgewater, New Jersey

Location ID	Field Sample ID	Date Sampled	Chemical Analyses					Fingerprinting	Physical Parameters								
			VOCs	Extended SVOCs	Bio-markers	PCBs	TAL Metals		Kinematic Viscosity @ 122 °F	Kinematic Viscosity @ 77 °F	Kinematic Viscosity @ 68 °F	Kinematic Viscosity @ 50 °F	Viscosity SFS @ 122 °F	Interfacial Tension	API Gravity @ 60 °F	Density @ 60 °F	Specific Gravity @ 60 °F
MW-102	PA031121-05 1:10	11/20/03		O				X									
MW-103	PA031121-06 1:10	11/20/03		O				X									
MW-104	PA031121-01 1:10	11/20/03		O				X									
MW-105	PA031121-04 1:10	11/20/03		O				X									
SEEP-1	PA031121-02	11/20/03		O				X									
SEEP-2	PA031121-03 1:10	11/20/03		O				X									
MW-102A	MW-102AD-112305	11/23/05	X	X	X	X	X	X	X				X	X	X	X	X
MW-105	MW-105D-112305	11/23/05	X	X	X	X	X	X	X				X	X	X	X	X
MW-112B	MW-112BD-112305	11/23/05	X	X	X	X	X	X	X				X	X	X	X	X
MW-116B	MW-116BD-112305	11/23/05	X	X	X	X	X	X	X				X	X	X	X	X
MW-107	MW-107D-120605	12/06/05	X	X	X	X	X	X	X				X	X	X	X	X
MW-7	MW-7L-052406	05/24/06	X	X	X	X	X	X	X				X	X	X	X	X
MW-123	MW-123-122008-D	12/20/08	X	X	X	X	X	X		X	X	X		X	X	X	X
MW-135	MW-135-122008-D	12/20/08	X	X	X	X	X	X		X	X	X		X	X	X	X
MW-105A	MW-105A-021109-L	02/11/09	X	X	X	X	X	X		X	X	X		X	X	X	X

Notes:
Sampling conducted in 2003 was performed by Parsons.

Analytical methods utilized are as follows:

API Gravity: Method ASTM-D4052
Biomarkers: Method SW8270M
Density: Method ASTM-D4052
Extended SVOCs: Method SW8270
Fingerprinting: Method 8100M
Interfacial Tension: Method ASTM-D971
Kinematic Viscosity: Method ASTM-D445
PCBs: Method SW8082
Specific Gravity: Method ASTM-D4052
TAL Metals: Method SW6010 and SW3050/7471
Viscosity: Method ASTM-D2161
VOCs: Method SW8260

API - American Petroleum Institute
PCB - polychlorinated biphenyl
SVOC - semi-volatile organic compound
TAL - Target Analyte List SW-846
VOC - volatile organic compound
o - Only select SVOC parameters were analyzed:

1,2,4-Trimethylbenzene, 1-Methylnaphthalene, 2-Methylnaphthalene, Acenaphthalene, Acenaphthylene, Anthracene, Benzene, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(e)pyrene, Benzo(g,h,i)perylene, Benzo(k)fluoranthene, C1-Dibenzothiophenes, C1-Fluoranthenes/pyrenes, C1-Fluorenes, C1-Naphthalenes, C1-Phenanthrenes/anthracenes, C2-Benz(a)anthracene/chrysene, C2-Dibenzothiophenes, C2-Fluoranthenes/pyrenes, C2-Fluorenes, C2-Naphthalenes, C2-Phenanthrenes/anthracenes, C3-Dibenzothiophenes, C3-Fluoranthenes/pyrenes, C3-Fluorenes, C3-Naphthalenes, C4-Naphthalenes, Chrysene, Dibenzothiophene, Dibenzo(a,h)anthracene, Dibenzofuran, Ethylbenzene, Fluoranthene, Fluorene, Indeno(1,2,3-cd)pyrene, Naphthalene, o-Xylene, Perylene, Phenanthrene, Pyrene, Styrene, Toluene, Xylenes, m & p - Xylenes.

TABLE 2-11

Summary of NAPL Fingerprinting and Physical Parameters

Quanta Resources Superfund Site, OU1

Edgewater, New Jersey

			Nov-05				Dec-05	May-06	Dec-08		Feb-09
Parameter	Method	Units	MW-102A	MW-105	MW-112B	MW-116B	MW-107	MW-7	MW-123	MW-135	MW-105A
Type of Material**			Coal Tar	Coal Tar	Coal Tar	Coal Tar	Coal Tar	Unknown Hydrocarbon	Coal Tar	Coal Tar	Coal Tar and Unknown Hydrocarbon
Kinematic Viscosity @ 122 °F	ASTM-D445	cSt	14.31	181.6	61.23	27.44	3.49	4.93	13.1****	4.9****	17.3****
Kinematic Viscosity @ 77°F	ASTM-D7042	cSt	---	---	---	---	---	---	150	17.7	105
Kinematic Viscosity @ 68°F	ASTM-D7042	cSt	---	---	---	---	---	---	230	22.7	146
Kinematic Viscosity @ 50°F	ASTM-D7042	cSt	---	---	---	---	---	---	633	38.2	308
Viscosity SFS @ 122 °F	ASTM-D2161	Second	N/A	86.4	31.1	N/A	N/A	N/A	---	---	---
Interfacial Tension	ASTM-D971	Dynes/cm	25.0	30.2	27.5	18.0	8.2	25.9	16.65	5.78	NM***
API Gravity @ 60 °F	ASTM-D4052	°API	-2.32	NM	-4.81	-6.2	3.15	29.8	-6.09	-1.64	17.0
Density @ 60 °F	ASTM-D4052	kg/m ³	N/A	NM	N/A	N/A	1049.8	876.8	1128.3	1089.6	951.7
Specific Gravity @ 60 °F	ASTM-D4052	none	1.0951	NM	1.1168	1.1293	1.0505	0.8772	1.1283	1.0896	0.9526

Notes:

*Type of Material is based on chemical analyses involving GC/FID fingerprinting (EPA Methods 8100 modified) and EPA Method 8260 and 8270 (for VOCs, SVOCs and petroleum biomarkers). An evaluation of diagnostic ratios and the comparison of these results to the in-house library at META Environmental, Inc. of Watertown, MA was also used to determine material type.

**Interfacial tension could not be determined on the NAPL sample from MW-105A due to the matrix; the analytical laboratory attempted using several needle and solvent types. The sample was observed to be very heterogeneous prior to centrifugation, having dark and very fine particulates are dispersed in the oil phase of the sample.

***Value based on extrapolation of kinematic viscosity at 50°F, 68°F, and 77°F using an exponential regression equation.

Coal Tar: coal carbonization tars, coke oven tars and creosotes

ASTM - ASTM International

cSt - centistoke

SFS - Saybolt Furol Second

cm - centimeters

NM - American Petroleum Institute (API) Gravity reading was not measured because sample was thick with what appeared to be a sediment-like material.

N/A - Not applicable

mN/m - millinewton / meter

TABLE 2-12

Summary of Target Pore Water Stations - Surface and Pore Water Quality Field Parameter Results

*Quanta Resources Superfund Site, OU1**Edgewater, New Jersey*

Sample Location	Northing	Easting	Probe Location	pH	Temp. (°C)	Cond. (mS/cm)	ORP (mV)	TDS (ppm)
TP7-A/GWZ-1	718543.934	633676.187	Surface	8.27	29.8	22.22	-35	21.06
			Pore Water	7.65	33.3	19.12	-145	17.38
TP11-A/GWZ-2	718705.407	633877.329	Surface	8.12	29.4	25.91	-124	25.35
			Pore Water	7.83	31	26.07	-304	25.39
TP4-D/GWZ-3	718249.947	633866.147	Surface	7.64	27.2	25.29	21	24.62
			Pore Water	7.87	29.9	19.48	-114	18.15
TP2-D/GWZ-4	718060.219	633817.425	Surface	7.83	25.9	24.56	1	23.87
			Pore Water	7.69	27.9	18.41	-111	16.93
TP2-A/GWZ-5	718138.832	633553.974	Surface	8.14	30.4	19.63	-150	18.22
			Pore Water	8.33	28.8	18.3	-273	16.76

Notes:

All sampling conducted in accordance with RI/FS Work Plan Addendum No.4

Pore water and surface sample parameters were measured with a Myron L Ultrameter

Pore water samples were collected between 1 and 2 feet below the sediment surface

Surface samples were collected less than 1 foot above the sediment surface

All field parameters were collected between July 14, 2008 and July 25, 2008

°C - degrees Celsius

mS/cm - milliSiemens per centimeter

mV - millivolt

ORP- Oxidation reduction potential

ppm - parts per million

TDS - total dissolved solids

TABLE 2-13

Summary of Transect Survey - Surface and Subsurface Temperature and Conductivity Field Parameter Results

*Quanta Resources Superfund Site, OU1**Edgewater, New Jersey*

Sample Location	Northing	Easting	Probe Location	Temp. (°C)	Cond. (mS/cm)
TP1-A	718083.67	633465.709	Surface	25.458	22.695
			Subsurface	23.738	14.834
TP1-B	718015.001	633560.232	Surface	25.367	22.088
			Subsurface	21.688	8.032
TP1-C	717968.126	633643.556	Surface	25.278	20.829
			Subsurface	20.971	8.563
TP1-D	717932.18	633726.817	Surface	23.839	26.246
			Subsurface	21.099	9.063
TP1-E	717878.035	633812.952	Surface	23.891	25.651
			Subsurface	20.983	8.928
TP2-A/GWZ-5 *	718138.832	633553.974	Surface	23.388	25.416
			Subsurface	21.119	4.332
TP2-B	718124.695	633628.802	Surface	23.372	25.342
			Subsurface	20.93	8.267
TP2-C	718103.37	633720.281	Surface	23.419	25.298
			Subsurface	20.891	9.343
TP2-D/GWZ-4 *	718060.219	633817.425	Surface	23.536	25.514
			Subsurface	20.473	9.258
TP2-E	718024.306	633906.222	Surface	23.555	25.364
			Subsurface	20.448	8.882
TP3-A	718284.795	633594.648	Surface	25.858	21.731
			Subsurface	20.764	9.022
TP3-B	718267.096	633683.338	Surface	25.776	21.614
			Subsurface	21.391	8.625
TP3-C	718223.864	633766.64	Surface	25.664	21.216
			Subsurface	21.546	10.375
TP3-D	718198.848	633849.836	Surface	25.49	21.268
			Subsurface	21.337	8.678
TP3-E	718170.043	633908.139	Surface	25.421	20.813
			Subsurface	20.71	10.023
TP4-A	718350.563	633627.485	Surface	25.555	18.843
			Subsurface	21.591	8.316
TP4-B	718307.218	633691.409	Surface	24.285	20.214
			Subsurface	21.207	10.079
TP4-C	718278.591	633780.162	Surface	24.271	20.366
			Subsurface	21.547	9.934
TP4-D/GWZ-3 *	718249.947	633866.147	Surface	24.276	20.532
			Subsurface	21.52	8.365
TP4-E	718224.85	633935.502	Surface	24.246	20.625
			Subsurface	21.005	8.936
TP5-A	718416.234	633643.712	Surface	25.73	18.718
			Subsurface	21.683	9.25
TP5-B	718376.629	633724.224	Surface	24.403	20.033
			Subsurface	21.675	9.648
TP5-C	718340.7	633810.251	Surface	24.744	20.275
			Subsurface	21.475	9.683
TP5-D	718308.43	633899.026	Surface	25.391	20.328
			Subsurface	20.856	9.037

TABLE 2-13

Summary of Transect Survey - Surface and Subsurface Temperature and Conductivity Field Parameter Results

*Quanta Resources Superfund Site, OU1**Edgewater, New Jersey*

Sample Location	Northing	Easting	Probe Location	Temp. (°C)	Cond. (mS/cm)
TP5-E	718268.68	633954.624	Surface	26.707	20.567
			Subsurface	21.164	8.596
TP6-A	718459.951	633643.457	Surface	25.688	18.904
			Subsurface	21.895	10.309
TP6-B	718424.118	633746.093	Surface	24.496	20.034
			Subsurface	21.798	10.306
TP6-C	718395.539	633843.151	Surface	24.801	20.359
			Subsurface	21.904	9.64
TP6-D	718363.269	633931.925	Surface	25.445	20.205
			Subsurface	21.336	8.555
TP6-E	718341.783	633995.722	Surface	26.406	20.487
			Subsurface	21.975	9.031
TP7-A/GWZ-1 *	718543.934	633676.187	Surface	25.928	18.884
			Subsurface	21.697	7.016
TP7-B	718504.426	633773.307	Surface	24.583	20.058
			Subsurface	21.951	9.846
TP7-C	718468.529	633864.871	Surface	25.19	20.406
			Subsurface	20.909	9.162
TP7-D	718436.227	633948.109	Surface	25.603	20.317
			Subsurface	21.566	8.995
TP7-E	718400.282	634031.368	Surface	26.489	20.555
			Subsurface	21.21	9.554
TP8-A	718613.345	633709.001	Surface	26.075	18.866
			Subsurface	22.214	9.835
TP8-B	718562.908	633806.186	Surface	24.668	20.124
			Subsurface	21.446	10.754
TP8-C	718526.931	633883.908	Surface	25.257	20.415
			Subsurface	21.79	9.321
TP8-D	718509.233	633972.597	Surface	25.927	20.459
			Subsurface	21.624	9.529
TP8-E	718469.532	634036.5	Surface	26.073	20.207
			Subsurface	22.22	9.252
TP9-A	718660.947	633750.248	Surface	26.209	18.769
			Subsurface	22.366	9.065
TP9-B	718632.174	633814.086	Surface	24.677	20.135
			Subsurface	21.646	9.613
TP9-C	718607.239	633911.122	Surface	25.596	20.345
			Subsurface	21.416	9.84
TP9-D	718563.975	633988.886	Surface	26.339	20.502
			Subsurface	21.255	9.822
TP9-E	718527.934	634055.536	Surface	25.965	20.247
			Subsurface	21.187	9.689
TP10-A	718672.49	633855.375	Surface	26.397	18.76
			Subsurface	22.527	8.105
TP10-B	718632.902	633938.654	Surface	26.504	19.197
			Subsurface	22.681	9.783

TABLE 2-13

Summary of Transect Survey - Surface and Subsurface Temperature and Conductivity Field Parameter Results
Quanta Resources Superfund Site, OU1
Edgewater, New Jersey

Sample Location	Northing	Easting	Probe Location	Temp. (°C)	Cond. (mS/cm)
TP10-C	718633.225	633994.018	Surface	26.478	19.332
			Subsurface	21.621	9.948
TP10-D	718600.81	634057.878	Surface	26.402	19.408
			Subsurface	21.564	9.874
TP10-E	718579.438	634141.052	Surface	26.754	19.364
			Subsurface	21.532	10.095
TP11-A/GWZ-2 *	718705.407	633877.329	Surface	28.86	N/A
			Subsurface	22.781	7.665
TP11-B	718691.32	633960.459	Surface	26.384	19.294
			Subsurface	21.586	10.133
TP11-C	718673.428	634015.929	Surface	26.162	19.459
			Subsurface	21.483	10.971
TP11-D	718644.753	634096.377	Surface	26.514	19.166
			Subsurface	21.182	9.132
TP11-E	718626.959	634168.457	Surface	26.511	19.514
			Subsurface	21.298	10.238

Notes:

All sampling conducted in accordance with RI/FS Work Plan Addendum No.4

Conductivity and temperature were measured by Coastal Monitoring Associate's (CMA) Trident Probe

Subsurface parameters were collected 2 feet below the sediment surface

Surface parameters were collected less than 2 feet above the sediment surface

All field parameters were measured between July 14, 2008 and July 25, 2008

* - Location selected for pore water sampling

°C - degrees Celsius

mS/cm - milliSiemens per centimeter

N/A - Surface probe was out of the water due to product on the surface

TABLE 3-1
Full Site Synoptic Water Levels - Mid-Tide - March 2009
Quanta Resources Superfund Site, OU1
Edgewater, New Jersey

Well Name	Measuring Point Elevation (ft msl)	DTW (ft)	GW Elevation (ft msl)
Shallow Unconfined Groundwater			
ACMW-1	11.29	7.27	4.02
ACMW-3	14.34	10.49	3.85
MW-101	10.63	6.25	4.38
MW-102A	9.69	5.48	4.21
MW-103A	10.03	5.12	4.91
MW-105A	8.2	6.6	1.6
MW-106A	6.65	5.83	0.82
MW-107A	7.04	3.96	3.08
MW-108	6.5	4.34	2.16
MW-109A	4.56	4.81	-0.25
MW-111A	7.98	3.85	4.13
MW-112A	10.01	5.38	4.63
MW-113A	10.2	6	4.2
MW-114A	7.41	4.13	3.28
MW-115A	7.14	5.39	1.75
MW-116A	9.45	6.38	3.07
MW-117A	9.37	6.42	2.95
MW-118A	9	6.62	2.38
MW-119A	6	4.91	1.09
MW-120A	6.83	5.11	1.72
MW-121A	7.13	3.32	3.81
MW-122A	7.24	3.86	3.38
MW-130A	6.34	2.61	3.73
MW-131	6.88	4.82	2.06
MW-132	5.9	4.79	1.11
MW-133	15.38	11.28	4.1
MW-134	14.13	13.59	0.54
MW-20	15.05	10.92	4.13
MW-22A	10.35	6.21	4.14
MW-25	7.09	4.77	2.32
MW-26*	9.57	NM	NM
MW-27	7.64	4.81	2.83
MW-29	7.09	3.57	3.52
MW-30	6.27	5.16	1.11
MW-31	7.1	3.98	3.12
MW-32	6.3	4.04	2.26
MW-36	7.37	3.71	3.66
MW-36(EE)	14.14	11.66	2.48
MW-51A	7.12	4.23	2.89
MW-7	6.94	6.11	0.83
MW-A-2	17.29	12.99	4.3
MW-B	15.4	11.23	4.17
MW-C	14.75	13	1.75
MW-D	15.27	11.36	3.91
MW-E	14.96	12.02	2.94
MW-F	11.29	10.14	1.15
MW-G	13.91	10.19	3.72
MW-H	19.36	14.15	5.21
MW-I	19.13	17.5	1.63
MW-J	16.09	14.45	1.64
MW-K*	13.92	NM	NM
MW-L	15.05	10.66	4.39
MW-M	15.56	11.5	4.06
MW-N-2	11.42	6.27	5.15
MW-O	15.51	12.48	3.03

Notes:

* - Monitoring well not accessible

Shallow unconfined groundwater - Well screen set at or near the water table
Deeper unconfined groundwater - Well screen set immediately above the silty-clay aquitard
Deep sand - Well screen set below silty-clay aquitard
Bedrock - Well screen set in bedrock

Depth to water measurements reported in feet below top of inner monitoring well casing or "measuring point".
Depth to water measurements taken during mid tide on March 17, 2009.

DTW - depth to water
ft msl - Feet referenced to mean sea level
NM - Not measured

Vertical datum: NAVD 88

Well Name	Measuring Point Elevation (ft msl)	DTW (ft)	GW Elevation (ft msl)
Shallow Unconfined Groundwater			
PZ-6S	5.72	3.59	2.13
PZ-7S	5.71	4.37	1.34
PZ-8S	4.46	2.84	1.62
MW-123	5.54	2.99	2.55
MW-124	7.48	4.65	2.83
MW-125	11.97	6.92	5.05
MW-126	13.87	9.45	4.42
MW-127	6.35	3.88	2.47
MW-128	8.69	2.69	6
MW-129	7.29	3.31	3.98
MW-136	5.02	2.27	2.75
MW-4*	7.53	NM	NM
Deeper Unconfined Groundwater			
DMW-2	14.14	11.39	2.75
MW-102	9.24	5.21	4.03
MW-102B	9.61	5.61	4
MW-103	8.57	4.55	4.02
MW-104R	9.11	7.52	1.59
MW-105	7.87	6.31	1.56
MW-106	7.13	6.36	0.77
MW-107	6.84	3.35	3.49
MW-109	4.49	4.59	-0.1
MW-111B	7.85	3.54	4.31
MW-112B	9.6	5.11	4.49
MW-113B	9.94	5.75	4.19
MW-113C	9.8	5.69	4.11
MW-114B	7.24	3.36	3.88
MW-115B	6.7	3.31	3.39
MW-116B	8.69	5.69	3
MW-116DS	9.18	5.6	3.58
MW-117B	9.04	6.1	2.94
MW-118B	9.4	7.66	1.74
MW-119B	5.68	4.63	1.05
MW-120B	6.78	6	0.78
MW-121B	7.16	3.29	3.87
MW-130B	6.47	2.74	3.73
MW-135	15	12.46	2.54
MW-A-1	16.06	11.73	4.33
MW-N-1	12	7.65	4.35
PZ-6I	5.74	3.02	2.72
PZ-7D	5.69	2.26	3.43
PZ-7I	5.66	3.94	1.72
PZ-8I	4.39	0.68	3.71
3Y-MW1	0	3.91	-3.91
Deep Sand Unit			
MW-101DS	10.45	6.09	4.36
MW-103DS	10.13	5.84	4.29
MW-107DS	6.82	2.59	4.23
MW-37D	7	2.41	4.59
PZ-8D	4.53	0.77	3.76
Bedrock Well			
MW-N-3	13.34	9.12	4.22
PZ-6D	5.79	2.58	3.21
Tidal Gauge			
TGS-1	12.58	12.06	0.52

TABLE 4-1

Soil Screening Criteria

Quanta Resources Superfund Site, OU1

Edgewater, New Jersey

Parameter	New Jersey Direct Contact Soil Remediation Standard		EPA Regional Soil Screening Level	
	Residential	Non-Residential	Residential	Industrial
Units	mg/kg	mg/kg	mg/kg	mg/kg
Inorganics				
Aluminum	78,000	NA	77,000	990,000
Antimony	31	450	31	410
Arsenic	19	19	0.39	1.6
Barium	16,000	59,000	15,000	190,000
Beryllium	16	140	160	2,000
Cadmium	78	78	70	810
Chromium, Total	NA	NA	280	1,400
Cobalt	1,600	590	23	300
Copper	3,100	45,000	3,100	41,000
Iron	NA	NA	55,000	720,000
Lead	400	800	400	800
Manganese	11,000	5,900	1,800	23,000
Mercury	23	65	6.7	28
Nickel	1,600	23,000	1,600	20,000
Selenium	390	5,700	390	5,100
Silver	390	5,700	390	5,100
Thallium	5	79	5.1	66
Vanadium	78	1100	550	7200
Zinc	23,000	110,000	23,000	310,000
VOCs				
1,1,2,2-Tetrachloroethane	1	3	2	9.8
1,1,2-Trichloroethane	2	6	1.1	5.5
1,1-Dichloroethane	8	24	3.4	17
1,1-Dichloroethene	11	150	250	1,100
1,2,4-Trichlorobenzene	73	820	87	400
1,2,4-Trimethylbenzene	NA	NA	67	280
1,2-Dibromo-3-chloropropane	0.08	0.2	0.0056	0.073
1,2-Dibromoethane	0.008	0.04	0.034	0.17
1,2-Dichlorobenzene	5,300	59,000	2,000	10,000
1,2-Dichloroethane	0.9	3	0.45	2.2
1,2-Dichloropropane	2	5	0.93	4.7
1,3,5-Trimethylbenzene	NA	NA	47	200
1,3-Dichlorobenzene	5,300	59,000	NA	NA
1,4-Dichlorobenzene	5	13	2.6	13
2-Butanone (MEK)	3,100	44,000	28,000	190,000
4-Methyl-2-Pentanone (MIBK)	NA	NA	5,300	52,000
Acetone	70,000	NA	61,000	610,000
Acrolein	0.5	1	0.16	0.68
Benzene	2	5	1.1	5.6
Bromodichloromethane	1	3	10	46
Bromoform	81	280	61	220
Bromomethane	25	59	7.9	35
Carbon disulfide	7,800	110,000	670	3,000
Carbon Tetrachloride	0.6	2	0.25	1.3
Chlorobenzene	510	7,400	310	1,500
Chloroethane	220	1,100	NA	NA
Chloroform	0.6	2	0.3	1.5
Chloromethane	4	12	1.7	8.4
Cis-1,2-Dichloroethene	230	560	780	10,000
Cis-1,3-Dichloropropene	2	NA	1.7	8.4
Cyclohexane	NA	NA	7,200	30,000
Dibromochloromethane	3	8	5.8	21
Dichlorodifluoromethane	490	230,000	190	780

TABLE 4-1

Soil Screening Criteria

Quanta Resources Superfund Site, OU1

Edgewater, New Jersey

Parameter	New Jersey Direct Contact Soil Remediation Standard		EPA Regional Soil Screening Level	
	Residential	Non-Residential	Residential	Industrial
Units	mg/kg	mg/kg	mg/kg	mg/kg
Ethylbenzene	7800	110,000	5.7	29
Isopropylbenzene	NA	NA	2,200	11,000
Methyl Acetate	78,000	NA	78,000	1,000,000
Methyl Tert-butyl Ether (MTBE)	110	320	39	190
Methylene chloride	34	97	11	54
o-Xylene	12,000	170,000	5,300	23,000
Styrene	90	260	6,500	38,000
Tetrachloroethene	2	5	0.57	2.7
Toluene	6,300	91,000	5,000	46,000
Trans-1,2-Dichloroethene	300	720	110	500
Trans-1,3-Dichloropropene	2	7	1.7	8.4
Trichloroethene	7	20	2.8	14
Trichlorofluoromethane	23000	340,000	800	3,400
Vinyl chloride	0.7	2	0.06	1.7
Xylenes, m & p	12,000	170,000	600	2,600
Xylenes, Total	12,000	170,000	600	2,600
PAHs				
2-Methylnaphthalene	230	2,400	310	4,100
Acenaphthene	3,400	37,000	3,400	33,000
Anthracene	17,000	30,000	17,000	170,000
Benzo(a)anthracene	0.6	2	0.15	2.1
Benzo(a)pyrene	0.2	0.2	0.015	0.21
Benzo(b)fluoranthene	0.6	2	0.15	2.1
Benzo(g,h,i)perylene	380,000	30,000	NA	NA
Benzo(k)fluoranthene	6	23	1.5	21
Chrysene	62	230	15	210
Dibenzo(a,h)anthracene	0.2	0.2	0.015	0.21
Fluoranthene	2,300	24,000	2,300	22,000
Fluorene	2,300	24,000	2,300	22,000
Indeno(1,2,3-cd)pyrene	0.6	2	0.15	2.1
Naphthalene	6	17	3.9	20
Pyrene	1,700	18,000	1,700	17,000
Non-PAH SVOCs				
1,1'-Biphenyl	3100	34,000	3900	51,000
2,4,5-Trichlorophenol	6100	68,000	6100	62,000
2,4,6-Trichlorophenol	19	74	44	160
2,4-Dichlorophenol	180	2,100	180	1,800
2,4-Dimethylphenol	1200	14,000	1200	12,000
2,4-Dinitrophenol	120	1,400	120	1,200
2,4-Dinitrotoluene	0.7	3	120	1,200
2,6-Dinitrotoluene	0.7	3	61	620
2-Chloronaphthalene	NA	NA	6300	82,000
2-Chlorophenol	310	2,200	390	5,100
2-Methylphenol	310	3,400	NA	NA
3&4-Methylphenol	31	340	NA	NA
3,3-Dichlorobenzidine	1	4	1.1	3.8
3-Nitroaniline	NA	NA	18	82
4-Chloroaniline	NA	NA	9	32
4-Nitroaniline	NA	NA	23	82
Acenaphthylene	NA	300,000	NA	NA
Acetophenone	2	5	7,800	100,000
Atrazine	210	2,400	2.1	7.5
Benzaldehyde	6,100	68,000	7,800	100,000
Bis(2-Chloroethoxy)methane	NA	NA	180	1800

TABLE 4-1

Soil Screening Criteria

Quanta Resources Superfund Site, OU1

Edgewater, New Jersey

Parameter	New Jersey Direct Contact Soil Remediation Standard		EPA Regional Soil Screening Level	
	Residential	Non-Residential	Residential	Industrial
Units	mg/kg	mg/kg	mg/kg	mg/kg
Bis(2-Chloroethyl)ether	0.4	2	0.19	0.9
Bis(2-Chloroisopropyl)ether	23	67	NA	NA
Bis(2-Ethylhexyl)phthalate	35	140	35	120
Butylbenzyl Phthalate	1200	14,000	260	910
Caprolactam	31,000	340,000	31,000	310,000
Carbazole	24	96	NA	NA
Diethyl Phthalate	49,000	550,000	49,000	490,000
Di-n-butyl Phthalate	6,100	68,000	6,100	62,000
Di-n-octyl Phthalate	2,400	27,000	NA	NA
Hexachlorobenzene	0.3	1	0.3	1.1
Hexachlorobutadiene	6	25	6.2	22
Hexachlorocyclopentadiene	45	110	370	3,700
Hexachloroethane	35	140	35	120
Isophorone	510	2,000	510	1,800
Nitrobenzene	31	340	31	280
n-Nitroso-di-n-propylamine	0.2	0.3	0.069	0.25
n-Nitrosodiphenylamine	99	390	99	350
Pentachlorophenol	3	10	3	9
Phenanthrene	NA	300,000	NA	NA
Phenol	18,000	210,000	18,000	180,000
PCBs				
Aroclor 1016	0.2	1	3.9	21
Aroclor 1221	0.2	1	0.17	0.62
Aroclor 1232	0.2	1	0.17	0.62
Aroclor 1242	0.2	1	0.22	0.74
Aroclor 1248	0.2	1	0.22	0.74
Aroclor 1254	0.2	1	0.22	0.74
Aroclor 1260	0.2	1	0.22	0.74

Notes:

Constituents not on this list have no applicable standards.

Shading indicates the lowest of the applicable standards for each parameter.

mg/kg - milligrams per kilogram

NA - No Applicable Standard

PRG - Preliminary Remediation Goal

VOCs - volatile organic compounds

PAHs - polycyclic aromatic hydrocarbons

SVOCs - semi-volatile organic compounds

PCBs - polychlorinated biphenyls

Sources:

New Jersey Administrative Code 7:26D. http://www.nj.gov/dep/srp/regs/rs/rs_appendix1.pdf. Accessed April 3, 2009.

USEPA. Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites. RSL Table Update. Sept 2008.

** The direct contact standard for arsenic is based on natural background

TABLE 4-2

SRI - Constituents Exceeding Screening Levels in Soil

Quanta Resources Superfund Site, OU1

Edgewater, New Jersey

				Number of Samples in which Parameter was Detected	Number of Samples Exceeding Lowest Screening Criterion		Maximum Concentration Detected in Unsaturated Soil 0-4 ft bgs (mg/kg)	Maximum Concentration Detected in Saturated Soil >4 ft bgs (mg/kg)
Parameter	Lowest Screening Criterion (mg/kg)		Total Number of Samples			Exceedance Rate		
Inorganics								
Antimony	NJ Res	31	78	48	2	2.6%	29	506
Arsenic	EPA Res	0.39	96	94	94	97.9%	3850	39500
Chromium, Total	EPA Res	280	78	78	1	1.3%	110	316
Cobalt	EPA Res	23	78	78	1	1.3%	16.8	32.7
Iron	EPA Res	55000	78	78	5	6.4%	64700	140000
Lead	NJ Res	400	78	78	16	20.5%	793	9910
Mercury	EPA Res	6.7	78	69	5	6.4%	51.7	137
Thallium	NJ Res	5	78	17	1	1.3%	2.8	23.8
Vanadium	NJ Res	78	78	78	5	6.4%	116	101
VOCs								
1,2,4-Trimethylbenzene	EPA Res	67	79	23	3	3.8%	65.9	157
1,3,5-Trimethylbenzene	EPA Res	47	79	19	2	2.5%	32.4	61.5
Benzene	EPA Res	1.1	79	24	7	8.9%	0.0043	11.8
Ethylbenzene	EPA Res	5.7	79	23	11	13.9%	18.9	104
Vinyl chloride	EPA Res	0.06	79	2	1	1.3%	N/A	0.26
PAHs								
2-Methylnaphthalene	NJ Res	230	79	47	8	10.1%	1030	1850
Benzo(a)anthracene	EPA Res	0.15	79	66	61	77.2%	1380	632
Benzo(a)pyrene	EPA Res	0.015	79	68	68	86.1%	838	409
Benzo(b)fluoranthene	EPA Res	0.15	79	67	60	75.9%	721	537
Benzo(k)fluoranthene	EPA Res	1.5	79	67	42	53.2%	676	232
Chrysene	EPA Res	15	79	68	21	26.6%	1100	574
Dibenzo(a,h)anthracene	EPA Res	0.015	79	59	59	74.7%	152	57.3
Fluoranthene	NJ Res	2300	79	69	1	1.3%	4030	2260
Indeno(1,2,3-cd)pyrene	EPA Res	0.15	79	66	58	73.4%	348	168
Naphthalene	EPA Res	3.9	79	58	19	24.1%	1900	5720
Pyrene	NJ Res	1700	79	68	1	1.3%	2930	1570
Non-PAH SVOCs								
Carbazole	NJ Res	24	79	56	10	12.7%	554	808

TABLE 4-2

SRI - Constituents Exceeding Screening Levels in Soil
 Quanta Resources Superfund Site, OU1
 Edgewater, New Jersey

Parameter	Lowest Screening Criterion (mg/kg)		Total Number of Samples	Number of Samples in which Parameter was Detected	Number of Samples Exceeding Lowest Screening Criterion	Exceedance Rate	Maximum Concentration Detected in Unsaturated Soil 0-4 ft bgs (mg/kg)	Maximum Concentration Detected in Saturated Soil >4 ft bgs (mg/kg)
PCBs								
Aroclor 1242	NJ Res	0.2	78	1	1	1.3%	N/A	0.205
Aroclor 1248	NJ Res	0.2	78	1	1	1.3%	1.32	N/A
Aroclor 1254	NJ Res	0.2	78	5	4	5.1%	1.09	2.34
Aroclor 1260	NJ Res	0.2	78	7	4	5.1%	0.67	1.91

Notes:

All concentrations are presented in milligrams per kilogram (mg/kg).

Only constituents exceeding the lowest of the screening criteria are included in this table.

N/A = No constituents in this zone exceeded the applicable screening criterion.

Only soil samples analyzed as part of the Supplemental Remedial Investigation are shown.

VOCs - volatile organic compounds

PAHs - polycyclic aromatic hydrocarbons

SVOCs - semi-volatile organic compounds

PCBs - polychlorinated biphenyls

EPA Res - EPA Regional Residential Soil Screening Level

EPA Indust - EPA Regional Industrial Soil Screening Level

ft bgs - feet below ground surface

NJ Res - New Jersey Residential Direct Contact Soil Remediation Standard

NJ Non Res - New Jersey Non-Residential Direct Contact Soil Remediation Standard

Sources:

New Jersey Administrative Code 7:26D. http://www.nj.gov/dep/srp/regs/rs/rs_appendix1.pdf.

USEPA. Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites. RSL Table Update. Sept 2008. <http://www.epa.gov/region09/superfund/prg/index.html>

TABLE 4-3
Groundwater Screening Criteria
Quanta Resources Superfund Site, OU1
Edgewater, New Jersey

Parameter	New Jersey Groundwater Quality Criteria		EPA Regional Screening Levels - Tap Water	EPA Maximum Contaminant Levels
	Higher of Class IIA and PQL	Interim Generic		
Units	µg/L	µg/L	µg/L	µg/L
Inorganics				
Aluminum	200	NA	37,000	NA
Antimony	6	NA	15	6
Arsenic	3	NA	0.045	10
Arsenic (III)	3	NA	0.045	NA
Arsenic (V)	3	NA	0.045	NA
Barium	6,000	NA	7,300	2,000
Beryllium	1	NA	73	4
Cadmium	4	NA	18	5
Chloride	250,000	NA	NA	NA
Chromium	70	NA	NA	100
Cobalt	NA	NA	11	NA
Copper	1,300	NA	1,500	1,300
Iron	300	NA	26,000	NA
Lead	5	NA	NA	15
Manganese	50	NA	880	NA
Mercury	2	NA	11	2
Nickel	100	NA	730	NA
Nitrogen, Nitrate	10,000	NA	58,000	10,000
Nitrogen, Nitrate + Nitrite	10,000	NA	NA	11,000
Nitrogen, Nitrite	1,000	NA	3,700	1,000
Selenium	40	NA	180	50
Silver	40	NA	180	NA
Sodium	50,000	NA	NA	NA
Sulfate	250,000	NA	NA	NA
Thallium	2	NA	2.4	2
Vanadium	NA	NA	180	NA
Zinc	2,000	NA	11,000	NA
VOCs				
1,1,1-Trichloroethane	30	NA	9,100	200
1,1,2,2-Tetrachloroethane	1	NA	0.067	NA
1,1,2-Trichloroethane	3	NA	0.24	5
1,1-Dichloroethane	50	NA	2.4	NA
1,1-Dichloroethene	1	NA	340	7
1,2,4-Trichlorobenzene	9	NA	8.2	70
1,2,4-Trimethylbenzene	NA	100	15	NA
1,2-Dibromo-3-Chloropropane	0.02	NA	0.00032	0.2
1,2-Dibromoethane	0.03	NA	0.0065	NA
1,2-Dichlorobenzene	600	NA	370	600
1,2-Dichloroethane	2	NA	0.15	5
1,2-Dichloropropane	1	NA	730	5
1,3,5-Trimethylbenzene	NA	100	12	NA
1,3-Dichlorobenzene	600	NA	NA	75
1,4-Dichlorobenzene	75	NA	0.43	NA
2-Butanone (MEK)	300	NA	7100	NA
2-Hexanone	NA	100	NA	NA
2-Nitroaniline	NA	100	NA	NA
2-Nitrophenol	NA	100	NA	NA
4-Methyl-2-Pentanone	NA	100	2,000	NA

TABLE 4-3
Groundwater Screening Criteria
Quanta Resources Superfund Site, OU1
Edgewater, New Jersey

Parameter	New Jersey Groundwater Quality Criteria		EPA Regional Screening Levels - Tap Water	EPA Maximum Contaminant Levels
	Higher of Class IIA and PQL	Interim Generic		
Units	µg/L	µg/L	µg/L	µg/L
Acetone	6,000	NA	22,000	NA
Acrolein	5	NA	0.042	NA
Benzene	1	NA	0.41	5
Bromodichloromethane	1	NA	1.1	NA
Bromoform	4	NA	8.5	NA
Bromomethane	10	NA	8.7	NA
Carbon Disulfide	700	NA	1,000	NA
Carbon Tetrachloride	1	NA	0.2	5
Chlorobenzene	50	NA	91	100
Chloroethane	NA	100	NA	NA
Chloroform	70	NA	0.19	NA
Chloromethane	NA	5	1.8	NA
Cis-1,2-Dichloroethene	70	NA	370	70
Cis-1,3-Dichloropropene	1	NA	0.43	NA
Cyclohexane	NA	100	13,000	NA
Dichlorodifluoromethane	1,000	NA	390	NA
Ethylbenzene	700	NA	1.5	700
Isopropylbenzene (Cumene)	700	NA	680	NA
Methyl Acetate	7,000	NA	37,000	NA
Methyl Tert-butyl Ether (MTBE)	70	NA	12	NA
Methylcyclohexane	NA	100	NA	NA
Methylene chloride	3	NA	4.8	NA
Styrene	100	NA	1,600	100
Tetrachloroethene	1	NA	0.11	5
Toluene	600	NA	2,300	1,000
Trans-1,2-Dichloroethene	100	NA	110	100
Trans-1,3-Dichloropropene	1	NA	NA	NA
Trichloroethene	1	NA	1.7	5
Trichlorofluoromethane	2,000	NA	1,300	NA
Vinyl chloride	0.08	NA	0.016	2
o-Xylene	1,000	NA	1,400	10,000
Xylenes, m & p	1,000	NA	200	10,000
Xylenes, Total	1,000	NA	200	10,000
PAHs				
2-Methylnaphthalene	NA	30	150	NA
Acenaphthene	400	NA	2,200	NA
Anthracene	2,000	NA	11,000	NA
Benz(a)anthracene	0.1	NA	0.029	NA
Benzo(a)pyrene	0.1	NA	0.0029	0.2
Benzo(b)fluoranthene	0.2	NA	0.029	NA
Benzo(g,h,i)perylene	NA	100	NA	NA
Benzo(k)fluoranthene	0.5	NA	0.29	NA
Chrysene	5	NA	2.9	NA
Dibenzo(a,h)anthracene	0.3	NA	0.0029	NA
Fluoranthene	300	NA	1,500	NA
Fluorene	300	NA	1,500	NA
Indeno(1,2,3-cd)pyrene	0.2	NA	0.029	NA
Naphthalene	300	NA	0.14	NA
Pyrene	200	NA	1,100	NA

TABLE 4-3
Groundwater Screening Criteria
Quanta Resources Superfund Site, OU1
Edgewater, New Jersey

Parameter	New Jersey Groundwater Quality Criteria		EPA Regional Screening Levels - Tap Water	EPA Maximum Contaminant Levels
	Higher of Class IIA and PQL	Interim Generic		
Units	µg/L	µg/L	µg/L	µg/L
Non-PAH SVOCs				
1,1'-Biphenyl	400	NA	1,800	NA
2,4,5-Trichlorophenol	700	NA	3,700	NA
2,4,6-Trichlorophenol	20	NA	6.1	NA
2,4-Dichlorophenol	20	NA	110	NA
2,4-Dimethylphenol	100	NA	730	NA
2,4-Dinitrophenol	40	NA	73	NA
2,4-Dinitrotoluene	10	NA	73	NA
2,6-Dinitrotoluene	10	NA	37	NA
2-Chloronaphthalene	600	NA	2900	NA
2-Chlorophenol	40	NA	180	NA
2-Methylphenol (o-Cresol)	NA	100	1800	NA
3&4-Methylphenol	NA	100	NA	NA
3,3-Dichlorobenzidine	30	NA	0.15	NA
3-Nitroaniline	NA	5	3.2	NA
4-Chloroaniline	30	NA	1.2	NA
4-Nitroaniline	NA	5	3.2	NA
4,6-Dinitro-2-Methylphenol	NA	100	NA	NA
4-Bromophenyl Phenyl Ether	NA	100	NA	NA
4-Chloro-3-Methylphenol	NA	100	NA	NA
4-Chlorophenyl Phenyl Ether	NA	100	NA	NA
4-Nitrophenol	NA	100	NA	NA
Acenaphthylene	NA	100	NA	NA
Acetophenone	700	NA	3700	NA
Atrazine	3	NA	0.29	3
Benzaldehyde	NA	100	3700	NA
Bis(2-Chloroethoxy)methane	NA	100	110	NA
Bis(2-Chloroethyl)ether	7	NA	0.012	NA
Bis(2-Chloroisopropyl)ether	300	NA	NA	NA
Bis(2-Ethylhexyl)phthalate	3	NA	4.8	6
Butylbenzyl Phthalate	100	NA	35	NA
Caprolactam	NA	3,500	18,000	NA
Carbazole	NA	5	NA	NA
Diethyl Phthalate	6,000	NA	29,000	NA
Di-n-butyl phthalate	700	NA	3,700	NA
Di-n-octyl phthalate	100	NA	NA	NA
Hexachlorobenzene	0.02	NA	0.042	1
Hexachlorobutadiene	1	NA	0.86	NA
Hexachlorocyclopentadiene	40	NA	220	50
Hexachloroethane	7	NA	4.8	NA
Isophorone	40	NA	71	NA
Nitrobenzene	6	NA	3.4	NA
n-Nitroso-di-n-propylamine	10	NA	0.0096	NA
n-Nitrosodiphenylamine	10	NA	14	NA
Pentachlorophenol	0.3	NA	0.56	1
Phenanthrene	NA	100	NA	NA
Phenol	2,000	NA	11,000	NA

TABLE 4-3
Groundwater Screening Criteria
Quanta Resources Superfund Site, OU1
Edgewater, New Jersey

Parameter	New Jersey Groundwater Quality Criteria		EPA Regional Screening Levels - Tap Water	EPA Maximum Contaminant Levels
	Higher of Class IIA and PQL	Interim Generic		
Units	µg/L	µg/L	µg/L	µg/L
PCBs				
Aroclor 1016	0.5	NA	0.96	0.5
Aroclor 1221	0.5	NA	0.0068	0.5
Aroclor 1232	0.5	NA	0.0068	0.5
Aroclor 1242	0.5	NA	0.034	0.5
Aroclor 1248	0.5	NA	0.034	0.5
Aroclor 1254	0.5	NA	0.034	0.5
Aroclor 1260	0.5	NA	0.034	0.5

Notes:

Constituents not on this list have no applicable standards.

Shading indicates the lowest of the applicable standards for each parameter.

NA - No Applicable Standard

VOCs - volatile organic compounds

PAHs - polycyclic aromatic hydrocarbons

SVOCs - semi-volatile organic compounds

PCBs - polychlorinated biphenyls

Sources:

New Jersey Groundwater Quality Standards: http://www.state.nj.us/dep/wms/bwqsa/gwqs_table1.html, accessed January 23, 2009.

New Jersey Interim Generic GW criteria: using http://www.state.nj.us/dep/wms/bwqsa/gwqs_table2.html. with http://www.nj.gov/dep/wms/bwqsa/gwqs_interim_criteria_table.htm and

<http://www.epa.gov/region09/superfund/prg/index.html>, accessed January 23, 2009.

EPA Regional Screening Levels Table: <http://www.epa.gov/region09/superfund/prg/index.html>, accessed January 23, 2009.

EPA Maximum Contaminant Levels: <http://www.epa.gov/safewater/contaminants/index.html#mcls>, accessed April 6, 2009.

TABLE 4-4

SRI - Constituents Exceeding Screening Levels in Groundwater

Quanta Resources Superfund Site, OU1

Edgewater, New Jersey

Parameter	Lowest Criterion (ug/L)	Number of Locations Sampled	Number of Locations in which Parameter was Detected	Number of Locations Exceeding Screening Criterion	Exceedance Rate	Maximum Detected Concentration (µg/L)
Inorganics*						
Aluminum	NJ GWQS 200	50	33	21	42.0%	65,900
Aluminum, Dissolved	NJ GWQS 200	48	22	12	25.0%	64,500
Antimony	NJ GWQS 6	48	15	7	14.6%	59.7
Antimony, Dissolved	NJ GWQS 6	48	12	5	10.4%	41.8
Arsenic	EPA RSL 0.045	48	38	38	79.2%	1,510,000
Arsenic, Dissolved	EPA RSL 0.045	48	37	37	77.1%	1,480,000
Beryllium	NJ GWQS 1	48	14	8	16.7%	14.9
Beryllium, Dissolved	NJ GWQS 1	48	18	9	18.8%	15
Cadmium	NJ GWQS 4	48	19	13	27.1%	16,300
Cadmium, Dissolved	NJ GWQS 4	48	20	11	22.9%	15,400
Chloride	NJ GWQS 250,000	54	54	31	57.4%	7,080,000
Cobalt	EPA RSL 11	48	23	11	22.9%	223
Cobalt, Dissolved	EPA RSL 11	48	24	10	20.8%	224
Iron	NJ GWQS 300	50	50	42	84.0%	2,370,000
Iron, Dissolved	NJ GWQS 300	48	45	39	81.3%	2,240,000
Lead	NJ GWQS 5	48	23	17	35.4%	1,180
Lead, Dissolved	NJ GWQS 5	48	16	8	16.7%	117
Manganese	NJ GWQS 50	50	50	49	98.0%	79,700
Manganese, Dissolved	NJ GWQS 50	48	48	47	97.9%	80,100
Mercury	NJ GWQS 2	48	9	1	2.1%	10.1
Nickel	NJ GWQS 100	48	22	3	6.3%	319
Nickel, Dissolved	NJ GWQS 100	48	25	3	6.3%	317
Selenium	NJ GWQS 40	48	15	1	2.1%	1,500
Selenium, Dissolved	NJ GWQS 40	48	11	1	2.1%	1,530
Sodium	NJ GWQS 50,000	50	50	43	86.0%	3,920,000
Sodium, Dissolved	NJ GWQS 50,000	48	48	42	87.5%	3,480,000
Sulfate	NJ GWQS 250,000	54	53	27	50.0%	12,100,000
Thallium	NJ GWQS 2	48	8	5	10.4%	163
Thallium, Dissolved	NJ GWQS 2	48	7	3	6.3%	65.1
Vanadium	EPA RSL 180	48	28	1	2.1%	236
Vanadium, Dissolved	EPA RSL 180	48	29	1	2.1%	229
Zinc	NJ GWQS 2,000	50	28	4	8.0%	4,280
Zinc, Dissolved	NJ GWQS 2,000	48	23	4	8.3%	4,170

TABLE 4-4

SRI - Constituents Exceeding Screening Levels in Groundwater

Quanta Resources Superfund Site, OU1

Edgewater, New Jersey

Parameter	Lowest Criterion (ug/L)	Number of Locations Sampled	Number of Locations in which Parameter was Detected	Number of Locations Exceeding Screening Criterion	Exceedance Rate	Maximum Detected Concentration (µg/L)
VOCS						
1,1-Dichloroethane	EPA RSL 2.4	40	7	2	5.0%	21.8
1,2,4-Trimethylbenzene	EPA RSL 15	40	24	17	42.5%	738
1,3,5-Trimethylbenzene	EPA RSL 12	40	19	13	32.5%	350
Benzene	EPA RSL 0.41	40	26	26	65.0%	3,630
Carbon tetrachloride	EPA RSL 0.2	40	1	1	2.5%	0.48
Ethylbenzene	EPA RSL 1.5	40	26	22	55.0%	813
Methylcyclohexane	NJ Interim 100	40	7	1	2.5%	108
Tetrachloroethene	EPA RSL 0.11	40	6	6	15.0%	10.5
Toluene	NJ GWQS 600	40	24	3	7.5%	2,870
Trichloroethene	NJ GWQS 1	40	8	5	12.5%	103
Vinyl chloride	EPA RSL 0.016	40	1	1	2.5%	1.1
Xylenes, m/p-	EPA RSL 200	40	25	10	25.0%	1,610
Xylenes, Total	EPA RSL 200	40	26	11	27.5%	2,290
PAHs						
2-Methylnaphthalene	NJ Interim 30	40	25	15	37.5%	2,450
Benzo(a)anthracene	EPA RSL 0.029	40	18	18	45.0%	3.92
Benzo(a)pyrene	EPA RSL 0.0029	40	8	8	20.0%	3.53
Benzo(b)fluoranthene	EPA RSL 0.029	40	9	9	22.5%	4.23
Benzo(k)fluoranthene	EPA RSL 0.29	40	9	7	17.5%	1.93
Chrysene	EPA RSL 2.9	40	17	1	2.5%	3.49
Dibenzo(a,h)anthracene	EPA RSL 0.0029	40	4	4	10.0%	0.848
Indeno(1,2,3-cd)pyrene	EPA RSL 0.029	40	8	8	20.0%	2.24
Naphthalene	EPA RSL 0.14	40	34	34	85.0%	13,500
Phenanthrene	NJ Interim 100	40	31	3	7.5%	180

TABLE 4-4

SRI - Constituents Exceeding Screening Levels in Groundwater

Quanta Resources Superfund Site, OU1

Edgewater, New Jersey

Parameter	Lowest Criterion (ug/L)	Number of Locations Sampled	Number of Locations in which Parameter was Detected	Number of Locations Exceeding Screening Criterion	Exceedance Rate	Maximum Detected Concentration (µg/L)
SVOCs		40				
1,4-Dichlorobenzene	EPA RSL 0.43	40	2	2	5.0%	1.6
2,4-Dimethylphenol	NJ GWQS 100	40	17	7	17.5%	1,660
2-Methylphenol	NJ Interim 100	40	11	2	5.0%	168
3&4-Methylphenol	NJ Interim 100	40	10	1	2.5%	188
Carbazole	NJ Interim 5	40	26	21	52.5%	358
Pentachlorophenol	NJ GWQS 0.3	40	1	1	2.5%	0.688

Notes:

All concentrations are presented in micrograms per liter (µg/L).

Only constituents exceeding the lowest of the screening criteria are included in this table.

With the exception of lead, iron and arsenic, all other inorganics shown on this table were not analyzed in groundwater samples collected prior to the SRI.

Only groundwater samples analyzed as part of the Supplemental Remedial Investigation are shown.

EPA RSL - EPA Regional Screening Level

MCL - Maximum Contaminant Level

NJ GWQS - New Jersey Groundwater Quality Standard

NJ Interim - New Jersey Interim Generic Groundwater Criteria

PAHs - polycyclic aromatic hydrocarbons

PCBs - polychlorinated biphenyls

SRI - Supplemental Remedial Investigation

SVOCs - semi-volatile organic compounds

VOCs - volatile organic compounds

Sources:

New Jersey Groundwater Quality Standards: http://www.state.nj.us/dep/wms/bwqsa/gwqs_table1.html, accessed January 23, 2009.New Jersey Interim Generic Groundwater Quality Criteria: using http://www.state.nj.us/dep/wms/bwqsa/gwqs_table2.html withhttp://www.nj.gov/dep/wms/bwqsa/gwqs_interim_criteria_table.htm and <http://www.epa.gov/region09/superfund/prg/index.html>, accessed January 23, 2009.EPA Regional Screening Levels Table: <http://www.epa.gov/region09/superfund/prg/index.html>, accessed January 23, 2009.EPA Maximum Contaminant Levels: <http://www.epa.gov/safewater/contaminants/index.html#mcls>, accessed April 6, 2009.

TABLE 4-5
Pore Water and Surface Water Compared to Surface Water Screening Criteria
Quanta Resources Superfund Site, OU1
Edgewater, New Jersey

Location ID				GWZ-1		GWZ-2		GWZ-3		GWZ-4		GWZ-5		
Field Sample ID				GWZ-1-PW-071808	GWZ-1-SW-071808	GWZ-2-PW-072108	GWZ-2-SW-072108	GWZ-3-PW-072208	GWZ-3-SW-072208	GWZ-4-PW-072408	GWZ-4-SW-072408	GWZ-5-PW-072508	DUP-072508 (PW)	GWZ-5-SW-072508
	Units	Screening Criteria (ug/l)	Source of Screening Value	1' below sediment	1' above sediment	1' below sediment	1' above sediment	1' below sediment	1' above sediment	1' below sediment	1' above sediment	1' below sediment	1' below sediment	1' above sediment
Inorganics, Total														
Aluminum	ug/L	87	Region 2 NJ - FW	636	--	2020	--	9910	--	3300	--	1100 J	712 J	--
Antimony	ug/L	30	Suter and Tsao 1996	6 U	--	4.5 U	--	2.1 U	--	6 U	--	4.4 U	3 U	--
Arsenic	ug/L	36	Region 2 NJ - SW	11.9 U	2.4 U	14.7 J	3 U	6.1 U	3 U	6.7 U	5.8 U	121	110	6.5 U
Barium	ug/L	NA		83.5 J	--	61.4 J	--	95.7 J	--	49.8 J	--	130 J	122 J	--
Calcium	ug/L	NA		196000	--	999000	--	130000 J	--	135000	--	169000	173000	--
Chromium	ug/L	44	Region 2 NJ - SW (Value for Cr III)	14.8	--	10.2 U	--	49.2	--	17.4	--	9.3 J	7.1 U	--
Cobalt	ug/L	5	Region 2 NY - FW	5.1 U	--	2.4 U	--	8.8 J	--	3.5 J	--	1.7 U	1.3 U	--
Copper	ug/L	3.1	Region 2 NJ - SW	25 U	--	17.4 J	--	69.7	--	25.5 U	--	15.2 U	3.7 U	--
Iron	ug/L	300	Region 2 NY - FW	24000	--	3600	--	22500	--	7920	--	2960 J	1990 J	--
Lead	ug/L	3.7845	Region 2 NY - FW	4	--	26	--	44.8	--	15.9	--	31.2 J	15.4 J	--
Magnesium	ug/L	NA		431000	--	520000	--	348000	--	351000	--	371000	383000	--
Manganese	ug/L	120	Suter and Tsao 1996	6990	--	762	--	4240	--	4740 J	--	482	451	--
Mercury	ug/L	0.77	Region 2 NJ - FW	0.2 U	--	0.2 U	--	0.29	--	0.2 U	--	0.31	0.21	--
Nickel	ug/L	8.2	Region 2 NJ - SW	25.1 J	--	7.3 U	--	300	--	13.9 J	--	40	26.5 J	--
Potassium	ug/L	NA		153000	--	168000	--	133000 J	--	150000	--	153000	156000	--
Silver	ug/L	1.9	Region 2 NJ - SW	1.1 J	--	10 U	--	1.1 U	--	10 U	--	10 U	10 U	--
Sodium	ug/L	NA		3180000	--	4040000	--	2870000	--	2880000 J	--	3130000	3250000	--
Thallium	ug/L	8	Region 2 NY - FW	2 U	--	7.9 U	--	2 U	--	5 U	5 U	5 U	5 U	5 U
Vanadium	ug/L	14	Region 2 NY - FW	4.7 U	--	1.6 U	--	23.7 J	--	9.8 U	--	6.7 U	5.1 U	--
Zinc	ug/L	66	Region 2 NY - SW	10.8 U	--	28.7 U	--	284	--	61.1 J	--	31	21.4	--
Inorganics, Dissolved														
Aluminum, Dissolved	ug/L	87	Region 2 NJ - FW	200 U	--	2000 U	--	200 U	--	200 U	--	582	435	--
Antimony, Dissolved	ug/L	30	Suter and Tsao 1996	2 U	--	6 U	--	6 U	--	6 U	--	4.7 U	6 U	--
Arsenic, Dissolved	ug/L	36	Region 2 NJ - SW	15.3	3 U	33.8 J	3 U	3 U	4.3 U	6.6 U	3.7 U	46.2	37.4	7.3 U
Barium, Dissolved	ug/L	NA		138 J	--	91.3 J	--	22.9 J	--	21.7 J	--	127 J	133 J	--
Calcium, Dissolved	ug/L	NA		197000	--	1120000	--	181000 J	--	135000	--	170000	173000	--
Chromium, Dissolved	ug/L	44	Region 2 NJ - SW (Value for Cr III)	8.8 J	--	8.8 U	--	6.3 U	--	5.9 U	--	8.3 U	6.9 U	--
Cobalt, Dissolved	ug/L	5	Region 2 NY - FW	6.8 U	--	50 U	--	50 U	--	1.7 U	--	1.4 U	1.4 U	--
Copper, Dissolved	ug/L	3.1	Region 2 NJ - SW	14.4 U	--	25 U	--	7.9 J	--	3.1 U	--	8.9 U	3.2 U	--
Iron, Dissolved	ug/L	300	Region 2 NY - FW	2820	--	100 U	--	57.1 U	--	82.2 U	--	1730	1250	--
Lead, Dissolved	ug/L	3.7845	Region 2 NY - FW	3 U	--	30 U	--	6 U	--	1.4 U	--	17 J	8.8 UJ	--
Magnesium, Dissolved	ug/L	NA		432000	--	557000	--	405000	--	354000	--	346000	345000	--
Manganese, Dissolved	ug/L	120	Suter and Tsao 1996	5920	--	654	--	23.6	--	6290 J	--	154	124	--
Mercury, Dissolved	ug/L	0.77	Region 2 NJ - FW	0.2 U	--	0.2 UJ	--	0.2 U	--	0.2 U	--	0.2 U	0.2 U	--
Nickel, Dissolved	ug/L	8.2	Region 2 NJ - SW	26.4 J	--	40 U	--	3.3 U	--	4.2 U	--	25.4 J	19.5 J	--
Potassium, Dissolved	ug/L	NA		154000	--	181000	--	178000 J	--	153000	--	150000	149000	--
Sodium, Dissolved	ug/L	NA		3260000	--	4340000	--	3340000	--	2880000	--	3020000	3100000	--
Vanadium, Dissolved	ug/L	14	Region 2 NY - FW	4.4 U	--	2.3 U	--	50 U	--	4.1 U	--	6.7 U	6.2 U	--
Zinc, Dissolved	ug/L	66	Region 2 NY - SW	8.1 U	--	20 U	--	4.4 U	--	11 U	--	18.6 J	15.2 U	--

TABLE 4-5
Pore Water and Surface Water Compared to Surface Water Screening Criteria
Quanta Resources Superfund Site, OU1
Edgewater, New Jersey

Location ID				GWZ-1		GWZ-2		GWZ-3		GWZ-4		GWZ-5		
Field Sample ID				GWZ-1-PW-071808	GWZ-1-SW-071808	GWZ-2-PW-072108	GWZ-2-SW-072108	GWZ-3-PW-072208	GWZ-3-SW-072208	GWZ-4-PW-072408	GWZ-4-SW-072408	GWZ-5-PW-072508	DUP-072508 (PW)	GWZ-5-SW-072508
	Units	Screening Criteria (ug/l)	Source of Screening Value	1' below sediment	1' above sediment	1' below sediment	1' above sediment	1' below sediment	1' above sediment	1' below sediment	1' above sediment	1' below sediment	1' below sediment	1' above sediment
VOCs														
1,1'-Biphenyl	ug/L	14	Suter and Tsao 1996	4.8	2 U	--	2 U	2.2 U	2 U	2 U	2 U	2 U	2 U	2 U
1,1-Dichloroethane	ug/L	47	Suter and Tsao 1996	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethene	ug/L	25	Suter and Tsao 1996	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2,4-Trimethylbenzene	ug/L	19	Region 2 NY - SW	5.5	1.2 J	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
1,3,5-Trimethylbenzene	ug/L	NA		0.95 J	0.8 J	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Acetone	ug/L	1500	Suter and Tsao 1996	7.6 J	10 U	24.4	10 U	111	20.6	60	9.7 J	10 U	10 U	10 U
Benzene	ug/L	190	Region 2 NY - SW	28	0.83 J	5.3	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Carbon disulfide	ug/L	0.92	Suter and Tsao 1996	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Chlorobenzene	ug/L	5	Region 2 NY - FW	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	ug/L	590	Suter and Tsao 1996 (Value for 1,2-Dichloroethene)	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Ethylbenzene	ug/L	4.5	Region 2 NY - SW	7.6	1.4	1.5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Isopropylbenzene	ug/L	2.6	Region 2 NY - FW	2.1	0.26 J	0.44 J	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
n-Propylbenzene	ug/L	128	Region 3 - FW (Value for propyl benzene)	0.53 J	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Toluene	ug/L	92	Region 2 NY - SW	1.8 U	0.39 U	0.32 J	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Trichloroethene	ug/L	47	Suter and Tsao 1996	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Xylene, o-	ug/L	1.8	Suter and Tsao 1996; m-xylene value used	4.1	0.77 J	0.7 J	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Xylenes, m/p-	ug/L	1.8	Suter and Tsao 1996; m-xylene value used	4.4	1.6 U	0.87 J	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Xylenes, Total	ug/L	19	Region 2 NY - SW	8.5	2.4 U	1.6	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Non-PAH SVOCs														
Carbazole	ug/L	NA		30.9	0.45 J	--	2 U	2.2 U	2 U	2 U	2 U	2 U	2 U	2 U
Dibenzofuran	ug/L	3.7	Region 3 - FW	18.1	5 U	--	5 U	5.6 U	5 U	5 U	5 U	5 U	5 U	5 U
bis(2-Ethylhexyl)phthalate	ug/L	0.6	Region 2 NY - FW	2 U	2.3	--	1.2 J	1.6 J	1.1 J	2 U	2 U	2 U	2 U	1.2 J
2,4-Dimethylphenol	ug/L	NA		5 U	5 U	--	5 U	5.6 U	5 U	5 U	5 U	5 U	5 U	5 U
2-Methylnaphthalene	ug/L	4.2	Region 2 NY - SW	37.4	2 U	--	2 U	2.2 U	2 U	2 U	2 U	2 U	2 U	2 U
Phenol	ug/L	200	Region 2 NY - FW/SW	2 U	2 U	--	2 U	2.2 U	2 U	2 U	2 U	2 U	2 U	2 U
3&4-Methylphenol	ug/L	543	Region 3 - FW (Value for 4-methylphenol)	2 U	2 U	--	2 U	2.2 U	2 U	2 U	2 U	2 U	2 U	2 U
PAHs														
Acenaphthene	ug/L	5.3	Region 2 NY - FW	31.2	0.918	--	0.2 U	0.22 U	0.2 U	0.2 U	0.2 U	0.547	0.494	0.2 U
Acenaphthylene	ug/L	5.3	Acenaphthene value used	0.588	0.422	--	0.2 U	0.22 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Anthracene	ug/L	3.8	Region 2 NY - FW	5 U	5 U	--	5 U	5.6 U	5 U	5 U	5 U	5 U	5 U	5 U
Benzo(a)anthracene	ug/L	0.03	Region 2 NY - FW	2.02	2.41	--	0.1 U	0.11 U	0.1 U	0.1 U	0.1 U	0.976 J	0.31 J	0.295
Benzo(a)pyrene	ug/L	0.015	Region 3 - FW	1.11	2.2	--	0.1 U	0.11 U	0.1 U	0.1 U	0.1 U	0.705 J	0.1 UJ	0.1 U
Benzo(b)fluoranthene	ug/L	0.015	Benzo(a)pyrene value used	1.24	2.42	--	0.2 U	0.22 U	0.2 U	0.2 U	0.2 U	0.674 J	0.2 UJ	0.163 J
Benzo(g,h,i)perylene	ug/L	0.015	Benzo(a)pyrene value used	0.507	1.07	--	0.2 U	0.22 U	0.2 U	0.2 U	0.2 U	0.298	0.2 U	0.2 U
Benzo(k)fluoranthene	ug/L	0.015	Benzo(a)pyrene value used	0.88	1.41	--	0.2 U	0.22 U	0.2 U	0.2 U	0.2 U	0.703 J	0.2 UJ	0.291
Chrysene	ug/L	0.015	Benzo(a)pyrene value used	1.13	1.65	--	0.2 U	0.22 U	0.2 U	0.2 U	0.2 U	0.694 J	0.225 J	0.215
Dibenzo(a,h)anthracene	ug/L	0.015	Benzo(a)pyrene value used	0.216	0.468	--	0.2 U	0.22 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Fluoranthene	ug/L	0.04	Region 3 - FW	11.5	5	--	0.2 U	0.22 U	0.2 U	0.2 U	0.2 U	1.94 J	0.904 J	0.624
Fluorene	ug/L	0.54	Region 2 NY - FW	20	0.638	--	0.2 U	0.22 U	0.2 U	0.2 U	0.2 U	0.208	0.2 U	0.2 U
Indeno(1,2,3-cd)pyrene	ug/L	0.015	Benzo(a)pyrene value used	0.476	1.02	--	0.2 U	0.22 U	0.2 U	0.2 U	0.2 U	0.322	0.2 U	0.2 U
Naphthalene	ug/L	13	Region 2 NY - FW	491	0.44	--	0.2 U	0.22 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Phenanthrene	ug/L	1.5	Region 3 - SW	28.5	2.11	--	0.2 U	0.22 U	0.2 U	0.2 U	0.2 U	0.417 J	0.2 UJ	0.2 U
Pyrene	ug/L	4.6	Region 2 NY - FW	8.1	4.14	--	0.2 U	0.22 U	0.2 U	0.2 U	0.2 U	1.89 J	0.859 J	0.473

Notes:
The lowest freshwater or salt water screening value was selected from Region II (NY or NJ), using surrogates as appropriate. If a screening value was not available from these sources, chronic screening values were selected first from Suter and Tsao (1996) and then from Region III, which is a compilation of sources.
The constituent mass flux to the surface water at OU2 has not been evaluated as part of the Supplemental Remedial Investigation
The pore water aliquot for Non-PAH SVOCs and PAHs analysis from location GWZ-2 was broken during laboratory processing; therefore, SVOC data from this sample are not available.
Constituents that are not known to be site related and for which all results were below the detection limits have not been included.
Concentrations above screening levels are marked as shaded and bold.
NA - Not Available
J - Estimated Concentration
U - Not Detected
ug/L - micrograms per liter
VOC - Volatile Organic Compound
SVOC - Semi-Volatile Organic Compound
PAH - Polycyclic Aromatic Hydrocarbon Compounds
FW - Freshwater
SW - Salt Water

TABLE 5-1
TOC and Arsenic by SEP Soil Sample Lithology Summary
Quantla Resources Superfund Site, OU1
Edgewater, New Jersey

Location	Start Depth (ft bgs)	End Depth (ft bgs)	Sampling Date	Soil Description	Lithology	Product	TOC ^{1,9} (mg/kg)	Total Arsenic ^{1,9} (mg/kg)	Soluble Arsenic ^{2,3} (mg/kg)	Easily Exchangeable outer sphere complexes Arsenic ^{2,4} (mg/kg)	Amorphous Fe oxyhydroxide Arsenic ^{2,5} (mg/kg)	Crystalline Fe oxyhydroxide Arsenic ^{2,6} (mg/kg)	Residual Arsenic ^{2,7} (mg/kg)	Total Arsenic ^{2,8} (mg/kg)	Arsenic SEP % Recovery ²	Soluble Iron ^{2,3} (mg/kg)	Easily Exchangeable outer sphere complexes Iron ^{2,4} (mg/kg)	Amorphous Fe oxyhydroxide Iron ^{2,5} (mg/kg)	Crystalline Fe oxyhydroxide Iron ^{2,6} (mg/kg)	Residual Iron ^{2,7} (mg/kg)	Total Iron ^{2,8} (mg/kg)	Iron SEP % Recovery ²
MW-126	15.25	15.75	10/14/2008	Fine SAND, clean, very dark brown, 7.5YR, 3/2, wet, medium dense	Fill	No	193,000	36.3	0.4420	0.419	2.520	0.261	1.135	4.530	105%	476	72.0	6930	4400	22370	43400	79%
	22	23		Fine sand, clean, strong brown, 7.5YR, 4/6, wet, medium dense	Native Sand	No	359	2.3	0.123	0.165	0.978	0.961	0.80	2.6	115%	128	24.4	2510	5430	17920	28170	92%
MW-128	8	9	2/25/2009	Fine to coarse well-graded sand and fine to medium subrounded GRAVEL, reddish brown, 5YR, 3/2, wet, dense	Sand	No	1100	3.8	0.0362	0.165	0.953	0.322	1.242	4.66	58%	65.7	11.7	1880	2770	21300	27200	96%
	13	14		Fine to coarse well-graded sand and fine to medium subrounded GRAVEL, reddish brown, 5YR, 3/2, wet, dense	Sand	No	1200	3.8	0.0695	0.328	1.66	0.706	0.972	3.780	99%	130	10.6	3770	6760	29400	34900	115%
MW-130B ¹⁰	15.3	15.8	10/9/2008	Wood with some silt coating, wet	Fill	No	881	192	1.560	3.570	5.300	0.132	2.360	13.500	96%	94.9	183	3470	3870	12650	23670	86%
	20	21		Fine to medium sand, well-sorted, trace fine sub-angular gravel, trace silty sand, obvious odor, brown, 7.5YR. 3/3, wet, loose	Native Sand	Yes	709	64.7	26.2	21.4	44.6	5.53	21.5	111.7	107%							
																184	20.1	653	4100	13600	21100	88%
MW-131 ¹¹	5.75	6.25	10/6/2008	Fine to medium sub-rounded GRAVEL, SLAG, SILTSTONE, fine angular GRAVEL, black, trace to some rounded coarse sand, trace fractured rock, wet, loose	Fill	No	381,000	4.7	0.581	4.630	2.020	0.670	19.200	24.000	113%	0.194	5.47	8300	3470	21100	43400	76%
	19.25	19.75		Organic/peaty clay, very dark brown, 7.5YR, 2.5/2, moist, wet, medium stiff	Meadow Mat (Peat)	No	33,900	15	0.432	0.171	0.329	0.243	11.37	12.2	103%	319	109	345	6060	31230	45100	84%
MW-132	10.5	11	10/7/2008	Fine to coarse sub-angular GRAVEL, some coarse roundedsand, wood, coal, and possible white slag pieces, trace mollusk shells and brick, trace to some slag, black, wet, loose	Fill	No	434,000	108	0.486	0.177	0.413	0.135	13.100	11.670	123%							
	19	20		Silty CLAY, some mollusk shells and organics, very dark grey, 7.5YR, 3/1, moist, soft	Organic Silt	No	25,200	10.7	0.479	0.285	0.815	0.879	14.0	15.0	110%	332	20.6	3010	6390	34270	46200	95%
MW-133 ¹²	13	13.5	10/2/2008	Silt with fine SAND, trace sub-rounded to coarse gravel, very dark grey, 7.5YR, 3/1, moist to wet	Native Sand	No	19,200	37.4	1.95	6.91	22.7	2.43	8.55	32.3	132%	ND (<2.1)	6.91	5830	3920	20010	33290	89%
MW-134	14.5	15	10/1/2008	SILT, little fine to coarse sand, trace brick and wood, black, moist to wet, loose, staining present, noticeable petroleum odor	Fill	No	81,300	192	16.8	76.4	32.9	0.893	299.3	387	110%	31.4	55.1	8750	5040	22140	40300	89%
	17	18		Silty SAND, some fine to coarse sub-rounded to sub-angular grave, trace brick, some product and staining in pore space, black, wet, medium dense	Fill	Yes	95,500	710	8.43	72.1	33.3	1.14	302	362	115%	86.2	106	29900	8780	29300	53100	128%
SB-53	2.5	3.5	9/5/2008	Crushed COAL and fine to coarse sub-rounded gravel, some wood, black, dry, medium dense, slight odor	Fill	No	703,000	187	1.37	12.9	56.4	55.9	39.8	171	97%	39.2	14.2	2680	8460	17100	27960	101%
	16	17		Fine to medium SAND, dark grey, 7.5YR, 4/1, wet, loose/medium dense, some fine to medium sub-rounded gravel	Native Sand	No	1,200	1220	73.9	38.5	170	63.6	66.4	413	100%	117	18.8	2130	4540	5579	19080	65%
SB-54	10.25	10.75	10/3/2008	SAND, SILT, trace wood and slag, dusky red, 10R, 3/3, wet	Fill	No	260,000	39500	167	204	4930	72	128	4745	116%	235	50.6	151000	31000	153000	406100	83%
	22.5	23		Fine to medium grained sand, trace localized product lenses and noticeable odor, very dark greyish brown, 10YR, 3/2, wet	Native Sand	Yes	1,200	9.3	0.162	0.091	1.08	0.106	1.306	2.46	96%	124	26.1	2020	2120	13760	25990	69%
SB-55	13.5	14	10/8/2008	Medium, well-sorted SAND, dark brown, 7.5YR, 3/4, wet, loose	Fill	No	NA	NA	13.700	10.300	13.400	6.88	20.400	52.640	123%	101	57.5	556	2540	12910	20170	80%
	19	20	10/7/2008	Medium, well-sorted SAND, dark brown, 7.5YR, 3/4, wet, loose, obvious odor present and stronger with depth	Native Sand	No	1,100	149	13.4	15.9	37.0	6.98	21.0	95.6	99%	28.9	28.1	1190	3410	12740	20850	83%

Notes:
ft bgs - feet below ground surface
mg/kg - milligrams per kilogram
TOC - total organic carbon
SEP- Sequential Extraction Procedure
NA - Not Analyzed (total arsenic and TOC sample was collected from 5-5.5 ft bgs)
¹ : Samples submitted to Accutest Laboratories of Dayton, New Jersey
² : Samples submitted to Applied Speciation and Consulting, LLC of Tukwilla, WA
³ : Deionized water used as extractant
⁴ : 0.05M (NH4)H2PO4 used as extractant
⁵ : 0.2M (NH4)2C2O4 used as extractant
⁶ : 0.2M (NH4)2C2O4 and 0.1M Ascorbic acid used as extractant
⁷ : Residual totals obtained by summing concentrations obtained using HF/HNO3/HCL (residual) and Aqua Regia (residual) as extractants
⁸ : Total obtained by summing concentrations obtained using HF/HNO3/HCL (original sample) and Aqua Regia (original sample) as extractants
⁹ : MW-126-15.25-15.75 sample collected from 11 to 11.5 feet bgs. MW-131 5.75-6.25 sample collected from 6-7 ft bgs. MW-132 10.5-11 sample collected from 8-9 ft bgs.
¹⁰ : Sample collected from "silt coating" on wood at 16 to 17 ft bgs
¹¹ : 19.25 to 19.75 feet bgs lithology was based off of 8 to 13' ft bgs due to no recovery in the sampled ranged.
¹² : Only one "shallow" sample collected due to the presence of bedrock at 13.8 feet bgs, shallower than the anticipated depth for the deep sample, 17 to 18 feet bgs.

TABLE 5-2

Evaluation of Arsenic Laboratory Data and Speciation using PHREEQC Geochemical Modeling

Quanta Resources Superfund Site, OU1

Edgewater, New Jersey

Well ID	Laboratory Results							Modeling Results	
	Accutest		Applied Speciation		Shaw Environmental and Infrastructure, Inc. (EPA Split Samples)			PHREEQC Dissolved Speciation Results	
	Arsenic	Arsenic, Dissolved	Arsenate, Dissolved	Arsenite, Dissolved	Arsenic, Dissolved	Arsenate, Dissolved	Arsenite, Dissolved	Arsenate	Arsenite
ACMW-3	3 U	3 U							
3Y-MW2	34.2	37							
MW-101A	34.5	14.4							
MW-103A	2.4 J	2 J							
MW-105A	1.7 J	3 U	1.06 J	0.23 J				0.0001	1.5
MW-106A	19.5	14.3							
MW-107A	17900	17400	6600	10200				14220	3261
MW-109	21	19.7							
MW-111B	32400	4460	1130	26200	35400	31700	2 U	4425	41
MW-112A	355	462							
MW-112B	32600	35200	16400	10500				0.001	35401
MW-113A	859	808							
MW-113B	7850	6080	2230	5540	7070	2580	3620	6098	0.047
MW-113C	1650	1460							
MW-114A	5.1 U	3.8 U	12 U	8.9 U				1.9	0.0004
MW-114B	10000	10700	958	9050				161	10571
MW-115A	85.9	80.4	22 J	42.2 J				79	1.0
MW-115B	30 U	15 U							
MW-117B	2.1 J	3 U							
MW-121A	1.9 U	3.4 U							
MW-121B	6 U	6.3 U							
MW-123	82.5	326							
MW-124	3 U	3 U							
MW-125	2.6 J	3.5							
MW-126	9	7.7	12 U	8.9 U				7	0.35
MW-127	3 U	4.1							
MW-128	3 U	3 U	0.184 U	0.415 J				1	2.05E-10
MW-129	3 U	3 U							
MW-130A	156	181	11 U	242	100	42	123	176	4.9
MW-130B	11100	10900	3770	5010				10879	72
MW-131	66.8	64.6							
MW-132	116	85.6	11 U	5.7 U	10 U	2 U	32	0.02	86
MW-133	3540	3380	526	1940				3386	3.3
MW-134	839	4320	7.2	311	4400	69	187	0.2	4339.5
MW-135	3 U	3 U							
MW-136	104	83.2							
MW-20	40	49	33.2	29.6	28	2 U	12	49	0.0001
MW-30	50.8	127							
MW-51A	782	731	94	532				622	112
MW-A-1	4890	4630							
MW-A-2	136000	136000	27100	104000				135084	1511
MW-B	1700	1290							
MW-C	460	452							
MW-F	47.3	28.5	11 U	25.3 J				0.002	29
MW-N-1	1510000	1480000							
MW-N-2	16100	14200	4620	8580				14160	71
MW-O	132	225	11 U	144				212	14

Notes:

1. All Concentrations reported in micrograms per liter (ug/L).
2. PHREEQC is modeling program for speciation, batch-reaction, one-dimensional transport, and inverse geochemical calculations.
3. Accutest - Accutest Laboratories based in Dayton, NJ.
4. Applied Speciation - Applied Speciation and Consulting, LLC based in Tukwilla, WA.
5. Split samples were collected by CDM on behalf of EPA and submitted to EPA's in-house analytical contractor for analysis. (Shaw Environmental and Infrastructure, Inc.; contract number EP-C-08-034)
6. U - Not Detected
7. J - Estimated Concentration
8. As - Arsenic